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THE TREATMENT OF OBESITY: AN ANALYSIS OF METHODS, RESULTS, AND FACTORS WHICH INFLUENCE SUCCESS

ALVAN R. FEINSTEIN, M.D.
NEW YORK, N. Y.

From the Department of Medicine, New York University College of Medicine, and Irvington House

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INCREASED interest in obesity in recent years has been followed by the appearance of numerous new diets, drugs, and devices intended to produce weight reduction. The procedures used for this purpose have been reported in many different ways in both lay and medical publications. Despite the frequency of these reports, they have seldom been accompanied by adequate amounts of numerical data, they have often presented unproved theories and conclusions, and the findings have rarely been subjected to satisfactory evaluation.

One major difficulty has been the lack of uniform criteria for measuring and reporting the results of dietary accomplishment. A second, and perhaps greater, problem has been the interpretation of the results. The explanations of the effects of weight reduction programs have been as varied as the programs themselves and the only consistent feature apparent in many of them has been their relationship to the orientation of the writer reporting them. When obese patients have successfully lost weight, nutritionists and dietitians have usually given sole credit to the constituents of the diet. Advertisements by beauty salons or physical culturists have praised the effectiveness of massage, vibration, and other body manipulation. Results reported by physicians have had their achievement attributed to the medications which were used. Psychiatrists' reports have placed major emphasis upon the patient's psychic improvement.

Because the treatment of obesity has been the source of so many conflicting claims, concepts, and contentions, there has long been a need for rigorous appraisal of the existing data. A separate report[40] has discussed the problems of

TABLE I. TECHNIQUES USED FOR WEIGHT REDUCTION

- *I. Restricted Environment*
  - A. Hospital
  - B. "Milk farm"
  - C. "Nutritional table"
- *II. Unrestricted (Outpatient) Environment*
  - A. Choice of different foods (Instruction in caloric selection and restriction)
    - 1. No adjuncts
    - 2. Dietary adjuncts
      - a. Appetite depressants
        - (1) Anorexiants
          - (a) Amphetamines
          - (b) Phenylpropanolamine
          - (c) Pipradrol
          - (d) Phenmetrazine
        - (2) Bulk-producing agents
        - (3) Preprandial carbohydrate
          - (a) Citrus juice
          - (b) Dextrose candy
        - (4) Production of nausea
          - (a) Digitalis
          - (b) Belladonna
          - (c) Apomorphine
        - (5) Low protein intake
      - b. Homeostatic alteration
        - (1) Exercise, massage, etc.
        - (2) High fat intake
        - (3) Dinitrophenol
        - (4) Diuretics
          - (a) Fluid restriction
          - (b) Salt restriction
          - (c) Mercurials, etc.
          - (d) Vitamin C
        - (5) Hormones
          - (a) Thyroid
          - (b) Pituitrin
          - (c) Lactogenic hormone
          - (d) Chorionic gonadotrophin
          - (e) "Lipotropic" agents
      - c. Mood alteration
        - (1) Individual psychotherapy
        - (2) Group meetings
        - (3) Hypnosis
        - (4) Special incentives
          - (a) "Performance index"
          - (b) Comparative wall charts
        - (5) Pharmaceutical agents
          - (a) Rauwolfia
          - (b) Dexamyl
          - (c) Obedrin
          - (d) Tranquilizers
  - B. No choice of food
    - 1. Milk
    - 2. Bananas and skim milk
    - 3. Protein powders
    - 4. Formula mixtures
    - 5. Prepackaged meals

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measuring and expressing accomplishment in weight reduction and has noted the deficiencies of most methods used for this purpose. An immediate difficulty is the tendency to ignore patients who reject or abandon dietary programs and to cite only the results with those who continue to participate. The lack of data based upon *all* the patients who started a diet often prevents a complete assessment of reported results. Another major difficulty is the lack of a satisfactory measurement of individual dietary performance. Although the rate of weight loss is frequently used, it has many deficiencies. The two most serious defects are that it gives falsely high results for patients who diet only briefly and it fails to indicate how close the patient has come to his goal. Other existing expressions—such as the "performance index," percentage excess weight loss, and the "Trulson criteria"[133]—have the disadvantages described previously. Some of these problems may be solved by the future use of a new "reduction index"[40] which was suggested to provide a uniform standard for reporting results.

Many of the published records of reduction programs have not used uniform techniques for reporting data, have not indicated the initial number of patients in the program, and have not expressed results in quantitative terms. Other reports have provided data which allow only approximate computations of the diet's effectiveness. A few have offered enough details for critical inspection. From this mixture of available literature, the pertinent data were assembled for the present analysis.

No attempt will be made to discuss the separate problem of why, when, and which obese patients should attempt weight reduction. Recent reviews[18,146,155,159] have pointed out the uncertainty of the statistical data relating obesity to morbidity and mortality and have indicated the practical difficulties which may occur when a lower target weight is imposed upon patients who have achieved psychic homeostasis while relatively obese. Many patients want to begin weight reduction because of cosmetic reasons rather than the physiologic and psychologic factors which have been cited. These multiple facets of the problem are complex and beyond the scope of the present work. Ultimately, the decision to prescribe a weight reduction program is made by the physician as a medical judgment. Within this framework, the selection of a program may be considered. The data reported here will be used to (1) classify the various therapeutic techniques in weight reduction, (2) tabulate and evaluate their results, and (3) analyze the nature and significance of factors which produce successful treatment.

MATERIAL AND METHODS

The available reports of dietary regimens were carefully inspected. The dietary components and adjuncts, the selection of patients, the nature of the therapeutic environment, the "side effects" of dieting, and other features were noted. Whenever numerical data existed, the results were tabulated. These included such features as the number of patients in the program, average length of the reduction period, amount of weight lost, initial weights of the patients, etc. Whenever possible, certain parameters of dietary success (such as rate of weight loss, percentage of patients who lost 20 pounds or more, etc.) were computed if they had not been stated originally. Of these parameters, the "rate of weight

TABLE II. RATES OF WEIGHT LOSS WITH DIETING IN RESTRICTED ENVIRONMENTS

INVESTIGATOR	CALORIES	COMPOSITION (GM.)			GENERAL STATUS	NUMBER OF PATIENTS	DURATION: AVERAGE AND (RANGE) (MO.)	WEIGHT LOSS: AVERAGE RATE AND (RANGE) (GM. PER DAY)
		C	P	F				
Dole and co-workers[26]	——	—	35	—	Hospitalized	26	(½–3)	165 (0–500)
Dole and co-workers[26]		—	81–131	—		22	(¾–1½)	79 (0–320)
Keeton and Bone[78]	1,050	85	90	40		8	(3–11)	161 (38–244)
Lyon and Dunlop[90]	1,000	—	—	—		14	½	145 (49–205)
Mason[93]	354–487	—	23–34	—		3	(3–3½)	365 (266–491)
Moller[97]	950	125	40	33		46	2 (¼–5)	159 (71–300)
Strang, McClugage, and Evans[129]	360	14	58	8		13	2 (¼–6)	302 (187–550)
Wilder, Smith, and Sandiford[138]	1,800–2,190	—	—	—		3	5½	123 (103–143)
Brown and Ohlson[16]	1,000–1,200	125–150	68–72	25–42	College women at nutritional table	8	(3–5)	109 (71–130)
Cederquist and co-workers[20]	1,200	184	66	22		4	4½	26 (1–59)
Cederquist and co-workers[20]	1,500	87	100	90		7	4	115 (79–150)
Leverton and Gram[87]	1,200	147	63	40		12	2	162 (118–185)
Young[141]	1,400	80	90	80		10	(3–3½)	123 (62–179)
Young, Ringer, and Greer[143]	1,400	80	90	80		6	2½	122 (91–169)
Young and co-workers[144]	1,800	104	115	103	College men at nutritional table	8	2	177 (105–216)

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loss" was available most frequently. For ease in comparison, all rates of weight loss were converted from their original units to grams per day. (The reader should recall that a loss of 1 pound per week is equal to 65 Gm. per day.) Another parameter, the "success" criteria of Trulson, Walsh, and Caso,[133] has previously been used in only a few reports. These criteria were applied in the present study to the results of other reports whenever the data permitted. Similarly, the percentages of patients losing more than 20 pounds and 40 pounds were also computed when possible.

In considering the tabulated rates of weight loss, it must be remembered that many authors have reported only those patients who persisted with a diet program (thus preselecting a "successful" group) or have given results of less than 2 months of active dieting (for which, as previously noted, the rates of loss are falsely high).

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RESULTS AND DISCUSSION

Table I classifies all the reported techniques which have been used for weight reduction. With the few exceptions noted below, all these techniques have been based on the principle that weight will be lost if the patient restricts caloric intake sufficiently. The problem has been how to get the patient to do so. The various methods used for this purpose and the results obtained with them have been tabulated using three parameters for measuring accomplishment: the rate of weight loss, the Trulson criteria, and the percentage of patients losing more than 20 to 40 pounds.

RATES OF WEIGHT LOSS

I. Restricted Environment.—The restriction of a patient's environment—to a hospital or elsewhere—has almost always been effective for producing adherence to a diet. The maintenance of food control is imposed upon the patient, who then can avoid the problem of choosing foods and their sizes, has little opportunity to obtain prohibited material, and has guardians to supervise his observance of the program. The discipline of environmental restriction and the companionship of individuals with similar trouble probably account for the popularity of "milk farms" and the use of "nutritional tables" in women's college dormitories. The hospital is the only locale in which a physician may be relatively certain that a dietary prescription has been observed. In many instances patients who have failed to lose weight at home despite "strict adherence" to a diet have lost weight in the hospital although the prescribed diet was unchanged.

The rates of weight loss in these restricted circumstances would be the most accurate indication of the effects of a prescribed diet, although even in such controlled environments occasional patients will "cheat" and thereby get falsely low results.

Table II and Fig. 1 show the rates of weight loss achieved with dieting in these locations. The highest rates in these groups were 302 and 365 Gm. per day, obtained in hospitalized patients drastically restricted to 360 to 400 calories a day in the diets introduced by Evans and Strang[38,129] and Mason.[92] Mean rates of

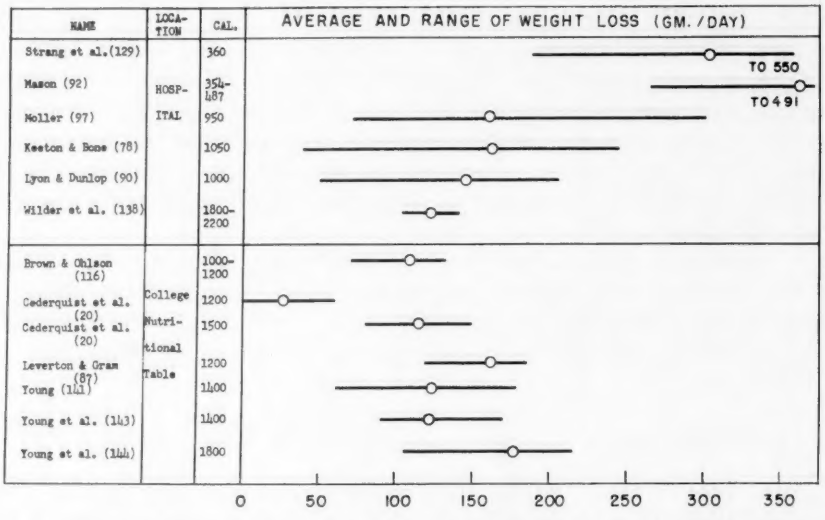

Fig. 1.—Rates of weight loss for dietary programs conducted in restricted environments. (Numbers in parentheses after names of investigators in this and subsequent figures are reference numbers.)

145, 159, 161, and 165 Gm. per day, respectively, were found in Lyon and Dunlop's[90] hospitalized group on 1,000 calories a day, in Moller's[97] group on 950 calories a day, in Keeton and Bone's[78] patients on about 1,050 calories a day, and in Dole and colleagues'[26] patients whose caloric intake was not recorded. A mean rate of 123 Gm. per day occurred in the 3 patients of Wilder, Smith, and Sandiford,[138] receiving 1,800 to 2,190 calories a day.

The college women who ate at special tables for nutritional studies had mean rates of loss varying from 26 to 162 Gm. per day on 1,000 to 1,500–calorie diets, whose contents were similar except for occasional differences in fat, protein, and carbohydrate ratios. Using a relatively low-protein, low-fat diet, Leverton and Gram's[87] patients had the highest results (162 Gm. per day) in this group. Cederquist and associates'[20] patients on a diet with similar protein content had the lowest results (26 Gm. per day) in this group. When Cederquist and coworkers[20] used, in a new group of patients, a relatively high-fat, high-protein diet, the rate of loss rose to 115 Gm. per day. The median value for these nutritional table results with women was about 120 Gm. per day. In a similar study[144] of college men, an 1,800-calorie diet produced a mean loss of 177 Gm. per day. Since no reports from milk farms have been found in the medical literature, results at these institutions cannot be cited.

These data permit the conclusion that under the strict environmental control of the hospital, rates of weight loss for dieting patients are consistent and are directly proportional to the amount of caloric deprivation. When the only environmental restriction is that of the nutritional table, the rates of weight loss show greater variation and are less directly related to the prescribed caloric intake.

II. Unrestricted (Outpatient) Environment.—

A. Choice of different foods:

1. No adjuncts.—Although environmental restriction is an effective method of producing weight reduction, it obviously has no general application. The classic approach to outpatient dieting has been to use standard foods, with the patient given either instructions in selection and caloric measurement or a fixed list of permissible choices. The diets have varied in both the prescribed total of calories and the distribution of fat-protein-carbohydrate components.

The results of such programs are given in Table III and Fig. 2. Inspection of the data shows marked variation in mean rates of weight loss. There is no consistent correlation between these rates and such features as caloric deprivation, dietary composition, and length of the period of weight reduction. The highest mean rates of loss (175 to 227 Gm. per day) appear in the three reports from Evans and Strang,[37-39] where drastic caloric restriction (400 to 680 calories a day) was imposed. This same diet in the hands of another physician, Kenyon,[80] produced the considerably lower mean value of 99 Gm. per day. The next highest

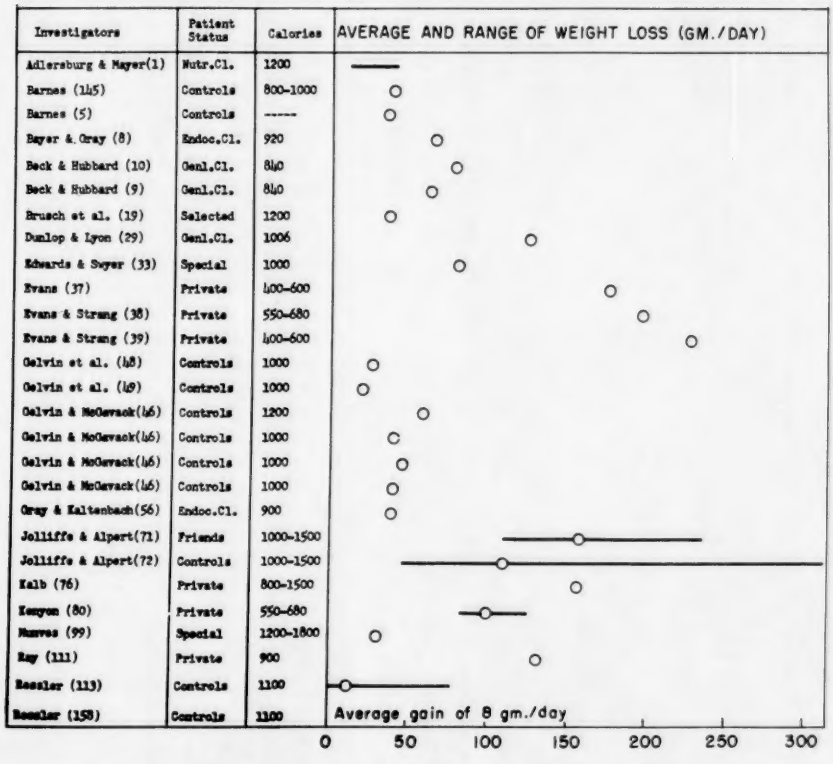
Investigators
Patient Status
Calories
AVERAGE AND RANGE OF WEIGHT LOSS (GM./DAY)
Adlersburg & Mayer(1) Nutr.Cl. 1200
Barnes (145) Controls 800-1000
Barnes (5) Controls -----
Bayer & Gray (8) Endoc.Cl. 920
Beck & Hubbard (10) Genl.Cl. 840
Beck & Hubbard (9) Genl.Cl. 840
Brusch et al. (19) Selected 1200
Dunlop & Lyon (29) Genl.Cl. 1006
Edwards & Swyer (33) Special 1000
Evans (37) Private 400-600
Evans & Strang (38) Private 550-680
Evans & Strang (39) Private 400-600
Gelvin et al. (48) Controls 1000
Gelvin et al. (49) Controls 1000
Gelvin & McGavack(46) Controls 1200
Gelvin & McGavack(46) Controls 1000
Gelvin & McGavack(46) Controls 1000
Gelvin & McGavack(46) Controls 1000
Gray & Kaltenbach(56) Endoc.Cl. 900
Jolliffe & Alpert(71) Friends 1000-1500
Jolliffe & Alpert(72) Controls 1000-1500
Kalb (76) Private 800-1500
Kenyon (80) Private 550-680
Mauves (99) Special 1200-1800
Ray (111) Private 900
Ressler (113) Controls 1100
Ressler (158) Controls 1100
Average gain of 8 gm./day
0
50
100
150
200
250
300

Fig. 2.—Rates of weight loss for outpatient dietary programs, using various food restrictions and no specific adjuncts.

TABLE III. RATES OF WEIGHT LOSS FOR OUTPATIENTS USING CALORICALLY RESTRICTED FOOD DIETS WITHOUT ANY ADJUNCTS

INVESTIGATOR	CALORIES	COMPOSITION (GM.)			GENERAL STATUS	NUMBER OF PATIENTS	DURATION: AVERAGE AND (RANGE) (MO.)	WEIGHT LOSS: AVERAGE RATE AND (RANGE) (GM. PER DAY)
		C	P	F				
Adlersburg and Mayer[1]	1,200	—	—	—	Nutrition clinic	132	(5½–11¾)	(11–42)
Barnes[5]	——	—	—	—	Controls for phenmetrazine study	93	(2–8)	35
Barnes[145]	800–1,000	—	—	40	Clinic controls for "Ambar" study	27	—	39
Bayer and Gray[8]	920	80	60	40	Endocrine clinic	100	3½	65
Beck and Hubbard[9]	840	40	80	40	General clinic	32	8	62
Beck and Hubbard[10]	840	40	80	40	General clinic	63	10	78
Brusch and co-workers[19]	1,200	—	—	—	Specially selected	40	2	36
Dunlop and Lyon[29]	1,006	100	66	38	General clinic	523	—	124
Edwards and Swyer[33]	1,000	91	57	45	Referred to special study	24	4	80
Evans[37]	400–600	—	—	—	Private patients	121	2	175
Evans and Strang[38]	550–680	45	60	—	Private patients	98	2	196
Evans and Strang[39]	400–600	—	—	—	Private patients	187	2	227
Gelvin, McGavack, and Kenigsberg[48]	1,000	100	75	40	Clinic; controls for pipradrol study	58	1½	26

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Gelvin, McGavack, and Kenigsberg[49]	1,000	100	75	40	Clinic; controls for phenmetrazine study	51	1½ 3	20
Gelvin and McGavack[46]	1,200	—	—	—	Controls for protein powder study	15		58
Gelvin and McGavack[46]	1,000	100	75	40	Controls for amphetamine study	64	1½	39
Gelvin and McGavack[46]	1,000	100	75	40	Controls for metamphetamine study	36	1½	45
Gelvin and McGavack[46]	1,000	100	75	40	Controls for vitamin C study	34	1	39
Gray and Kaltenbach[56]	900	80	60	40	Selected; endocrine clinic	212	6	38
Jolliffe and Alpert[71]	1,000–1,500	"High protein"			Special friends and relatives	11	(1–3)	157 (110–234)
Jolliffe and Alpert[72]	1,000–1,500	"High protein"			Private patients; controls for "performance index" study	44	(1–3)	110 (47–312)
Kalb[74]	800–1,500	"High protein"			Private patients	125	4	156
Kenyon[80]	550–680	45	60	—	Private patients	50	3	99 (83–124)
Munves[99]	1,200–1,800	—	—	—	Dietetic interviews	24	4	31 (2–118) 122—women
Ray[111]	900	—	—	—	Private patients	110	3	142—men
Ressler[113]	1,100	—	—	—	Clinic; controls for phenmetrazine study	16	4	14 (0–77)
Ressler[158]	1,100	—	—	—	Clinic; controls for triiodothyronine study	13	6 (1–9)	8—gain

mean rate of weight loss (157 Gm. per day) occurred in Jolliffe and Alpert's[71] group of "long-time friends or relatives who could be trusted not to deviate . . . from the prescribed diet." A similar rate (156 Gm. per day) was obtained by Kalb[74] in a group of private patients not subject to the same element of selection. The influence of patient selection is further indicated in the two reports from Jolliffe and Alpert.[71,72] With their selected group described above, the rate was 157 Gm. per day. With an unselected group of obese patients, the mean rate was lowered to 110 Gm. per day, although the same diet was used. In other reports, essentially similar diets used with carefully selected patients did not produce the same results. Brusch and associates[19] and Gray and Kaltenbach[56] found rates of only 36 and 38 Gm. per day, respectively.

Among the lower rates reported, the 62 and 78 Gm. per day in Beck and Hubbard's[9,10] groups are noteworthy, since their patients had one of the highest records of performance when measured by total weight loss (as shown later in Table X).

The groups reported by Barnes,[5,145] Brusch and coauthors,[19] Gelvin and colleagues,[46-49] Ressler,[113,158] and Robillard[117] are of interest since they served as "controls" for simultaneous studies with anorexigenic agents. The mean rates of loss for both the "control" and the experimental groups in these reports (Table IV) are lower than those reported in other studies where unsupplemented diets were used. Gelvin and his co-workers[46-49] have reported six different "control" groups. Mean rates of 20 to 45 Gm. per day were found in five of their groups on the same 1,000-calorie diet. The highest rate in their patients (58 Gm. per day) occurred in a sixth group on a higher caloric intake (1,200 calories a day) studied over a longer period of time. In one of the groups reported by Ressler,[158] the mean rate was a *gain* of 8 Gm. per day.

From these data, it is apparent that different investigators have obtained markedly different mean rates of weight loss with standard food diets despite the essential similarity of the diets and also that changes in total calories and diet constituents have not consistently affected the results.

2. Dietary adjuncts.—

a. Appetite depressants:

(*1*) *Anorexiants.* Since caloric instructions alone have not generally produced dietary adherence, a variety of adjuncts have been devised for this purpose. One target of attack has been the "appetite," depression of which has been attributed to the agents described below.

Most popular among these agents have been the anorexiants. These drugs have usually been prescribed together with caloric restriction, although in isolated instances no specific dietary limitations were made. As with most new therapeutic agents, initial reports were highly enthusiastic and indicated excellent effectiveness. With more general use, their frequent failures became more apparent and newer preparations were developed.

(The tabulations of anorexiants and other medicinal adjuncts given below have not cited dosage schedules because they varied considerably in different

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programs and often were changed at different intervals in individual patients. Except when prepared in delayed-release forms, these medications have almost all been employed preprandially.)

The results with anorexiant adjuncts are shown in Table IV and Fig. 3. The highest mean rate of weight loss with Dexedrine (208 Gm. per day) was found by Ersner[76] in private patients who maintained diets of 1,200 to 1,500

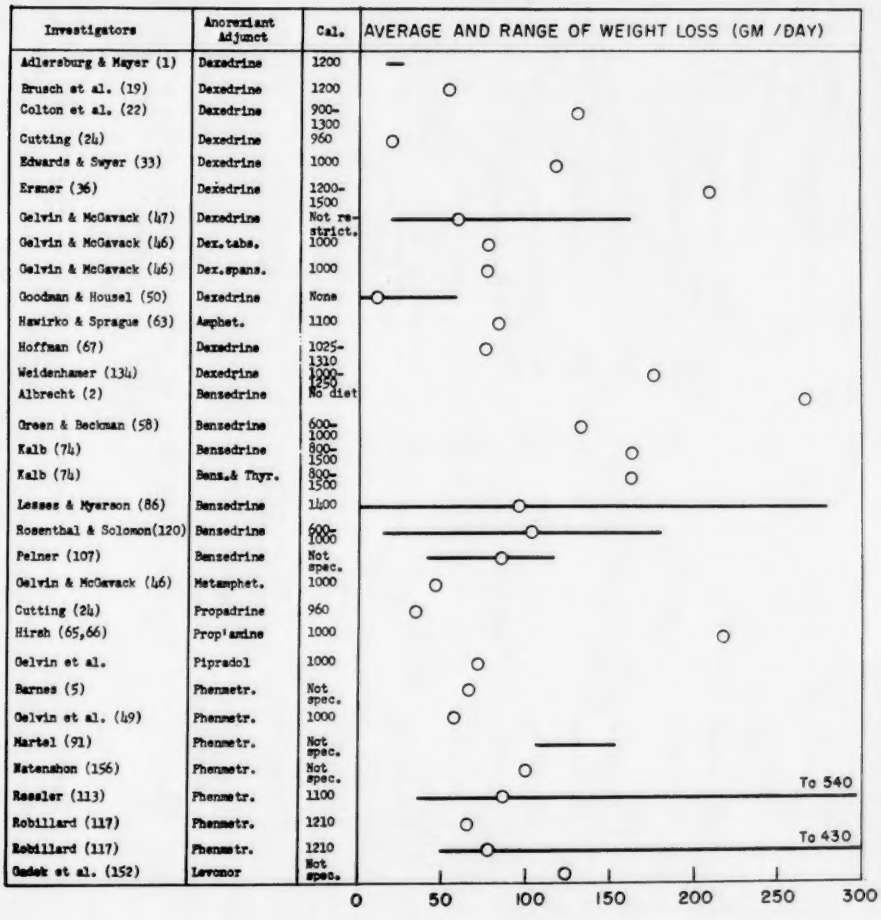
Investigators
Anorexiant Adjunct
Cal.
AVERAGE AND RANGE OF WEIGHT LOSS (GM /DAY)
Adlersburg & Mayer (1) Dexedrine 1200
Brusch et al. (19) Dexedrine 1200
Colton et al. (22) Dexedrine 900-1300
Cutting (24) Dexedrine 960
Edwards & Swyer (33) Dexedrine 1000
Ersner (36) Dexedrine 1200-1500
Gelvin & McGavack (47) Dexedrine Not restrict.
Gelvin & McGavack (46) Dex.tabs. 1000
Gelvin & McGavack (46) Dex.spans. 1000
Goodman & Housel (50) Dexedrine None
Hawirko & Sprague (63) Amphet. 1100
Hoffman (67) Dexedrine 1025-1310
Weidenhamer (134) Dexedrine 1000-1250
Albrecht (2) Benzedrine No diet
Green & Beckman (58) Benzedrine 600-1000
Kalb (74) Benzedrine 800-1500
Kalb (74) Benz.& Thyr. 800-1500
Lesses & Myerson (86) Benzedrine 1400
Rosenthal & Solomon(120) Benzedrine 600-1000
Pelner (107) Benzedrine Not spec.
Gelvin & McGavack (46) Metamphet. 1000
Cutting (24) Propadrine 960
Hirsh (65,66) Prop'amine 1000
Gelvin et al. Pipradol 1000
Barnes (5) Phenmetr. Not spec.
Gelvin et al. (49) Phenmetr. 1000
Martel (91) Phenmetr. Not spec.
Watenabon (156) Phenmetr. Not spec.
Ressler (113) Phenmetr. 1100
Robillard (117) Phenmetr. 1210
Robillard (117) Phenmetr. 1210
Gudek et al. (152) Levonor Not spec.
To 540
To 430
0
50
100
150
200
250
300

Fig. 3.—Rates of weight loss for outpatient dietary programs, using various food restrictions and anorexiant adjuncts.

calories for 1 to 3 months. (The percentage of those who abandoned the diet was not cited.) The lowest value in the Dexedrine diet groups was the mean of 20 Gm. per day in Cutting's[24] clinic patients on 960 calories for an average of 3 months. The patients of Gelvin and McGavack,[46-49] without any definite caloric instructions, produced higher mean rates of weight loss than those on specific

TABLE IV. RATES OF WEIGHT LOSS FOR OUTPATIENTS USING ANOREXIANT DIETARY ADJUNCTS

INVESTIGATOR	DRUG	CALORIES	COMPOSITION (GM.)			GENERAL STATUS	NUMBER OF PATIENTS	DURATION: AVERAGE AND (RANGE) (MO.)	WEIGHT LOSS: AVERAGE RATE AND (RANGE) (GM. PER DAY)
			C	P	F				
Adlersburg and Mayer[1]	Dexedrine	1,200	—	—	—	Nutrition clinic	90	(3-12)	(17-27)
Brusch and co-workers[19]	Dexedrine	1,200	—	—	—	"No compulsive eaters"	40	2	54
Colton and co-workers[22]	Dexedrine	900-1,300	High protein			Private practice	300	(2-18)	130
Cutting[24]	Dexedrine	960	80	70	40	Endocrine clinic	6	3	20
Edwards and Swyer[33]	Dexedrine	1,000	91	57	45	Special study	24	4	117
Ersner[36]	Dexedrine	1,200-1,500	—	—	—	Private practice	500	(1-3)	208
Gelvin and McGavack[47]	Dexedrine	Ate as pleased				Clinic; weekly visits	30	5 (1-10)	59 (20-162)
Gelvin and McGavack[46]	Dexedrine	1,000	—	—	—	Before-meal tablets	103	1½	78
Gelvin and McGavack[46]	Dexedrine	1,000	—	—	—	Sustained release capsules	104	1½	78
Goodman and Housel[50]	Dexedrine	No dietary restrictions				Test of effect on blood pressure	14	5 (4-7)	12 (0-53)
Hawirko and Sprague[63]	Dexedrine or Benzedrine	1,100	—	—	—	Private patients	72	5 (2-12)	83
Hoffman[67]	Dexedrine	1,025-1,310	81-93	29-55	108-150	Children and adolescents	60	4	75
Weidenhamer[134]	Dexedrine	1,000-1,250	—	—	—	Private patients	35	1½ (¼-3)	175
Albrecht[2]	Benzedrine	No special diet				Hospital personnel	300	(½-2)	266
Green and Beckman[58]	Benzedrine	600-1,000	—	—	—	Not stated	671	?	131

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Kalb[74]	Benzedrine	800-1,500	High protein			Private patients	125	4	162
Kalb[74]	Benzedrine plus thyroid	800-1,500	High protein			Private patients	125	4	162
Lesses and Myerson[86]	Benzedrine	1,400	150	69	57	Private patients	17	4 (1½-6)	95 (0-279)
Rosenthal and Solomon[120]	Benzedrine	600-1,000	—	—	—	Clinic	14	1	102 (13-179)
Pelner[107]	Benzedrine	——	—	—	—	Additional atropine, thyroid, etc.	6	(3-8½)	85 (41-114)
Gelvin and McGavack[46]	Metamphetamine	1,000	—	—	—	Obesity clinic	44	1½	45
Cutting[24]	Phenylpropanolamine	960	80	70	40	Endocrine clinic	13	2½	33
Hirsh[65,66]	Phenylpropanolamine	1,000	—	—	—	Private patients	11	2 (¼-4)	216
Gelvin, McGavack, and Kenigsberg[48]	Pipradrol	1,000	100	75	40	Obesity clinic	60	1½	71
Barnes[5]	Phenmetrazine	——	—	—	—	Office practice	93	(2-4)	67
Gelvin, McGavack, and Kenigsberg[49]	Phenmetrazine	1,000	100	75	40	Obesity clinic	53	1½	58
Martel[91]	Phenmetrazine	——	—	—	—	Office and hospitalized patients	118	?	(106-152)
Natenshon[156]	Phenmetrazine	——	—	—	—	—	109	(¼-2)	99
Ressler[113]	Phenmetrazine	1,100	—	—	—	Endocrine clinic	14	3 (¾-4)	87 (36-540)
Robillard[117]	Phenmetrazine	1,210	132	58	50	Diabetics; weekly visits	51	2½ (½-6)	66
Robillard[117]	Phenmetrazine	1,210	132	58	50	Diabetics in special study	12	3	76 (52-430)
Gadek, Feldman, and Lucariello[152]	Levonor	Special instructions				Study clinic	80	(¼-9)	129

diets given by Adlersburg and Mayer,[1] Brusch and co-workers,[19] and Cutting.[24] This contrasts with the observation of Goodman and Housel[50] that patients taking Dexedrine who did not follow a specific diet lost only 12 Gm. per day.

The highest mean rate in all the anorexiant groups was the 266 Gm. per day reported by Albrecht,[2] whose patients were hospital personnel taking Benzedrine for ½ to 2 months without a specific diet. Under the same regimen, Pelner's[107] patients lost an average of 85 Gm. per day. Other available reports with Benzedrine show mean rates of 95 to 130 Gm. per day. In a test of an amphetamine derivative, Gelvin and McGavack[46] found a rate of 45 Gm. per day. Combinations of amphetamines have been discussed by Freed and Mizel[45] and a variety of anorexiants were considered by Williams and coauthors,[139] but these reports did not contain data regarding the rates of weight loss with the proposed agents.

Phenylpropanolamine, a "newer" agent 15 years ago, was tested by Cutting[24] and dismissed as ineffective, in that it produced a loss of only 33 Gm. per day. Using this same drug and a 1,000-calorie diet, Hirsh[65,66] reported 216 Gm. per day lost in private patients; no data were given for those who did not continue the regimen.

In recent years, three new agents have appeared. Although results with pipradrol[48] were considered superior to those with the "control" group, the mean rate of loss in clinic patients was only 71 Gm. per day. Phenmetrazine was enthusiastically reported by Martel[91] to have produced a loss of 106 to 152 Gm. per day "in general" for 118 patients followed in the hospital or in private practice. Gelvin, McGavack, and Kenigsberg[49] found a much lower result in their phenmetrazine clinic group on 1,000 calories for an average of 1½ months. These patients did better than their control group, but the average rate was only 58 Gm. per day. Ressler's[113] recent work with this agent reported a mean loss of 87 Gm. per day. In two separate tests, Robillard[117] found rates of 66 and 76 Gm. per day. Natenshon's[156] and Barnes'[5] groups lost means of 99 and 67 Gm. per day, respectively. The newest drug of this type is 1-phenyl-2-aminopropane alginate (Levonor), for which an average loss of 129 Gm. per day was reported in 80 patients treated in a special study.[152]

The results obtained with anorexiant agents therefore (1) are in many instances inferior to those obtained with unsupplemented diets, (2) show the same marked variations present in the tabulated results of diet alone, and (3) indicate that the newer agents often compare poorly with the older ones whose deficiencies they presumably were intended to correct.

(*2-5*) *Other appetite depressants.* The use of bulk-producing substances became popular in the hope that these would "fill the stomach" and reduce the desire for food. Quantitative results with these agents are present in only a few reports. Using methylcellulose, caloric restriction, and patient selection to "avoid compulsive eaters," Brusch and colleagues[19] found an average weight loss of 46 Gm. per day. In a brief note on 10 patients followed for 2 months on this agent, Badham[3] reported a range of 57 to 244 Gm. per day. In his specially selected patients who took a bulk agent without a specific diet, Jonas[78] found a mean loss of 73 Gm. per day; in an unselected group on a similar regimen, the rate was 55 Gm. per day. (Table V.)

Certain experimental theories[93] a number of years ago had suggested that appetite was decreased when there was a large difference between arterial and venous blood sugar values. Accordingly, obese humans were fed carbohydrate preparations before meals in the hope that this would lower the prandial desire for food. Dextrose candy[19,53] or citrus fruit juice[71] was the agent used, together with diets of 1,000 to 1,400 calories. The reported mean rates of weight loss in three series of patients were 100, 124, and 214 Gm. per day.

The deliberate pharmaceutical production of nausea has been another approach to the problem. Bram's[13,14] private patients, on diets of 1,000 calories or less, received digitalis for this purpose and lost weight at a mean rate of 95 Gm. per day. No cardiac complications were reported. Green[57] stated that belladonna reduced appetite in 40 of 45 patients but gave no data for caloric intake or weight loss. Cutting[24] reported 5 patients who received belladonna for 1 month but failed to lose weight. Baumeister and Darling[7] used apomorphine, possibly more for its effect on mood than on appetite, and found that it "failed on all" of a group of 20 women.

Among the more novel concepts of recent years has been Dole's[26] theory that a low protein intake would reduce appetite. Dole[27] had originally observed that hospitalized, nonobese, hypertensive patients on a low-salt, low-protein diet had lost weight and he inferred that this was due to the low protein content of the diet. To test this theory, he gave hospitalized obese patients a basal diet which limited protein to 35 Gm. per day but allowed "unrestricted" intake of fat and carbohydrate. The food came from standard hospital supplies and patients chose their "unlimited" intake of fat and carbohydrate from "a bowl of sugar, a dish of jelly, and a large section of butter" with "rock candy available on request." When protein supplementation was added to this basal diet, 14 of 16 patients had a lower rate of weight loss (see Table I). An over-all mean rate of 165 Gm. per day was found in the patients on 35 Gm. of protein per day compared to 79 Gm. per day when the protein intake was supplemented. Results of this diet are also reported on 10 outpatients who were followed for an unspecified period of time with a mean loss of 137 Gm. per day (Table V). Other results with the outpatient use of the diet showed no consistent effects. When this diet was used in the hospital, the available fat and carbohydrate selections were obviously not the kind ordinarily available in an unrestricted environment, and Dole acknowledged that hospitalization alone might have played a role in the weight loss. He concluded, however, that "limitation in protein caused a fairly consistent reduction of appetite" because the rate of weight loss was smaller when the protein intake was increased.

The assumption that a loss in weight represents a loss in appetite is open to question. Although 7 patients are said to have decreased their caloric intake during the protein-supplemented periods, no precise data were listed for the caloric intakes during the control or experimental periods for any of the group. No measurements of fluid losses were recorded, and the authors did not consider the well-demonstrated[79,100,101,103] role of water excretion as a mechanism of weight change during isocaloric or other shifts of dietary constituents. Thus the results of these low-protein diet studies can be alternatively explained: the hospitalized

TABLE V. RATES OF WEIGHT LOSS FOR OUTPATIENTS USING NONANOREXIANT APPETITE DEPRESSANTS

INVESTIGATOR	AGENT	CALORIES	COMPOSITION (GM.)			GENERAL STATUS	NUMBER OF PATIENTS	DURATION: AVERAGE AND (RANGE) (MO.)	WEIGHT LOSS: AVERAGE RATE AND (RANGE) (GM. PER DAY)
			C	P	F				
Bulk agents									
Badham[3]	Methylcellulose	——	—	—	—	Not stated	10	2	(57-244)
Brusch and co-workers[19]	Methylcellulose	1,200	—	—	—	"No compulsive eaters"	40	2	46
Jonas[73]	Siblin or Cellothyl	None given				Specially selected and instructed	20	5 (4-10)	73 (42-159)
Jonas[73]	Siblin or Cellothyl	None given				No selection or instructions	20	—	55 (0-91)
Preprandial carbohydrate									
Brusch and co-workers[19]	Low-calorie candy	1,200	—	—	—	"No compulsive eaters"	40	2	100
Gordon and von Stanley[53]	Dextrose candy	1,200–1,400	—	—	—	Young women	21	3	214
Jolliffe and Alpert[71]	Citrus juice	1,000–1,400	High protein			Private patients	42	(1-3)	124 (65-203)
Miscellaneous									
Bram[13]	Digitalis	1,000 or less	—	—	—	Private patients	140	4	95
Dole and co-workers[26]	Low protein	"Unrestricted"	—	35	—	Special clinic	10	?	137 (0-215)

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patients lost weight because they were denied access to appealing foods and had all the environmental features conducive to weight loss; they lost more weight on the low protein intake because it temporarily resulted in increased water excretion. Until more convincing data are advanced, the conjecture that the intake of protein influences appetite remains unproved.

Results with the nonanorexiant appetite depressants thus have shown no consistent effect attributable to those agents. As with other techniques, the same procedures have shown different results for different investigators.

b. Homeostatic alteration: A number of methods of weight reduction have attempted to increase energy production, provide foods which would not be metabolized, or alter the homeostasis of body water and hormonal balance.

(*1*) *Exercise, massage, etc.* There has been ample demonstration[100,103,157] that exercise is an ineffective method of increasing energy output, since it takes far too much activity to burn up enough calories for a significant weight loss. In addition, physical exertion may evoke a desire for food so that the subsequent intake of calories may exceed what was lost during the exercise. Many physicians have, therefore, not advocated exercise as an important adjunct in weight reduction. Recent papers[28,94] have lamented the decline of attention to exercise and have enthusiastically recommended its use, particularly as a measure for *preventing* weight gain. However, no clinical results have been cited to indicate its *therapeutic* effectiveness in weight reduction.

Reducing salons, using massages, vibrators, and other physical therapy techniques, have had a great wave of popularity. Data from these salons have appeared only as isolated claims in commercial advertisements and no scientific reports are available. That massage and other physical therapies have any value in weight reduction has never been proved. The urge to "lose inches without dieting" is irresistible for many women and the popularity of institutions which offer this is understandable. However, Kalb's[76] classic studies have conclusively demonstrated that massage alone is of no value in weight or size reduction. When his patients followed a diet and lost weight (Table VI), the circumference of their limbs became smaller and the reduction in size of the massaged limb was identical to that of the unmassaged limb. When his patients failed to follow a diet and did not lose weight, the size of their limbs remained unchanged although weekly massages were given. Other work by Short and DePaul[124] and by Cuthbertson[23] is consistent with these observations. Despite these convincing facts to the contrary, the reducing salons continue to advertise that their programs produce alteration in body dimensions. In the absence of scientific data, it is impossible to verify these claims. It is possible, however, to attribute any observed successes to some of the following features of the treatment used:

> Simultaneously with the treatments, a calorically restricted diet is given—whether it is labeled "diet" or not—and adherence to the diet produces the true weight loss which reduces dimensions regardless of massage, vibrations, etc. Maintenance of the diet is encouraged by the expensiveness of these salons and by the psychotherapeutic aspects of their atmosphere.

TABLE VI. RATES OF WEIGHT LOSS FOR OUTPATIENTS RECEIVING DIETARY ADJUNCTS INVOLVING "HOMEOSTATIC ALTERATION"

INVESTIGATOR	AGENT	CALORIES	COMPOSITION (GM.)			GENERAL STATUS	NUMBER OF PATIENTS	DURATION: AVERAGE AND (RANGE) (MO.)	WEIGHT LOSS: AVERAGE RATE AND (RANGE) (GM. PER DAY)
			C	P	F				
High fat intake									
Pennington[108]		"Unrestricted"	High fat			Not stated	20	3½ (1-6)	92 (29-201)
Exercise									
Kalb[76]	Massage	800	—	—	—	Private patients	40	2¼	192
Kalb[76]	Massage	No diet used				Private patients	20	1½	1
Dinitrophenol (DNP)									
Bayer and Gray[8]	DNP	920	80	60	40	Clinic	23	1¾	107
Grant and Schube[64]	DNP	None used				Study of cholesterol	13	⅔	0
Simkins[126]	DNP	——	—	—	—	Clinic	59	1¼	110
Tainter, Stockton, and Cutting[131]	DNP	General instruction				Private practice	177	3	91 (61-200)

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Hormones and miscellaneous									
Adlersburg and Mayer[1]	Thyroid	1,200	—	—	—	Nutrition clinic	61	(5-7)	(6-24)
Bayer and Gray[8]	Thyroid	920	80	60	40	Clinic	51	3	55
Dunlop and Lyon[29]	Thyroid	1,006	—	—	—	Clinic	?523	?	98
Edwards and Swyer[33]	Thyroid	1,000	91	57	45	Special study	24	4	95
Eidelsberg[34]	Thyroid plus pituitary	"Decreased"				Clinic	81	6	111
Gray and Kaltenbach[56]	Thyroid	900	80	60	40	Specially selected	212	5	39
Kalb[75]	Thyroid	880–1,500	High protein			Weekly visits	125	4	156
Simkins[126]	Thyroid	——	—	—	—	Controls; DNP study	22	2	97
Ressler[158]	1-Triiodothyronine	1,100	—	—	—	Nutrition clinic	13	8 (3-13)	22 (9-45)
Weidenhamer[134]	1-Triiodothyronine	1,000–1,250	—	—	—	Dexedrine also used	35	1½ (½-3)	127
Werner[136]	Pituitrin	1,350–1,500	—	—	—	Not stated	77	4½	97
Sapoznik[122]	Lipotropic agent	1,000	100	100	20	Not stated	14	1½	206

The hedonistic effects of body manipulation please many women, so that they enjoy the program and report it favorably even if no change in body size results.

Physical procedures may produce transient shifts in subcutaneous fluid (e.g., elastic stockings for leg edema, loss of water with perspiration in steam rooms) which create temporary changes in surface measurements.

The measurement of the circumference of an obese surface is often difficult and extreme care is needed for accuracy. If the tape is pulled tighter in consecutive measurements, a "loss" can be produced in surface size without any real change having occurred.

(*2*) *High fat intake.* Pennington[108-110] has repeatedly postulated that obese patients have a pyruvate block and cannot adequately metabolize fat, although this theory has not been supported by any direct physiologic or biochemical data. Using this premise, Pennington created a diet which was unrestricted in fat intake, so that the patient's craving for food would be sated by substances which presumably could not be used for energy. Twenty patients were reported[108] to have lost an average of 92 Gm. per day under this regimen. There was no indication of how many calories these patients had actually ingested, how carefully they had followed the prescribed regimen, or how many had not done well. The absence of these data permitted the alternative explanation[30-32,43] that Pennington's patients had really found the diets unpalatable, did not eat the additional fat, and had in effect consumed the equivalent of a standard reduced-calorie, high-protein diet with which they lost weight. Werner[137] later tested Pennington's hypotheses by giving the high-fat, high-calorie diet to hospitalized patients in whom adherence to the diet was certain. No significant weight loss was elicited and some patients actually gained weight.

Some support for the Pennington hypothesis is given by Lyon and Dunlop[90] and by Kekwick and Pawan,[79] who maintained their patients on isocaloric intakes of different composition and found the most rapid rates of weight loss with a high fat intake. Since the period of dieting was only 7 to 9 days in each patient, these data cannot be applied to most problems in weight reduction, which involve much longer time intervals. Kekwick and Pawan noted that the insensible loss of water was greatest with high fat intake, and the incremental weight loss differences of their patients have been attributed[64] to shifts in water which might have been equilibrated if longer experimental periods had been used. The Pennington diet has also recently been advocated by Thorpe,[132] although no specific clinical data were cited.

(*3*) *Dinitrophenol.* Dinitrophenol (DNP) became popular in the treatment of obesity because of physiologic data which suggested that it increased the body metabolic rate. Its use was later abandoned (and outlawed in some states) because of severe toxic effects. The results obtained before its use was stopped failed to show any unusual evidence of its clinical effectiveness in weight reduction. In three available studies with this agent,[8,126,131] the mean rates of loss were 91 to 110 Gm. per day, and these could easily be attributed to the concomitant use of a low-calorie diet. That adherence to a diet was necessary for "success"

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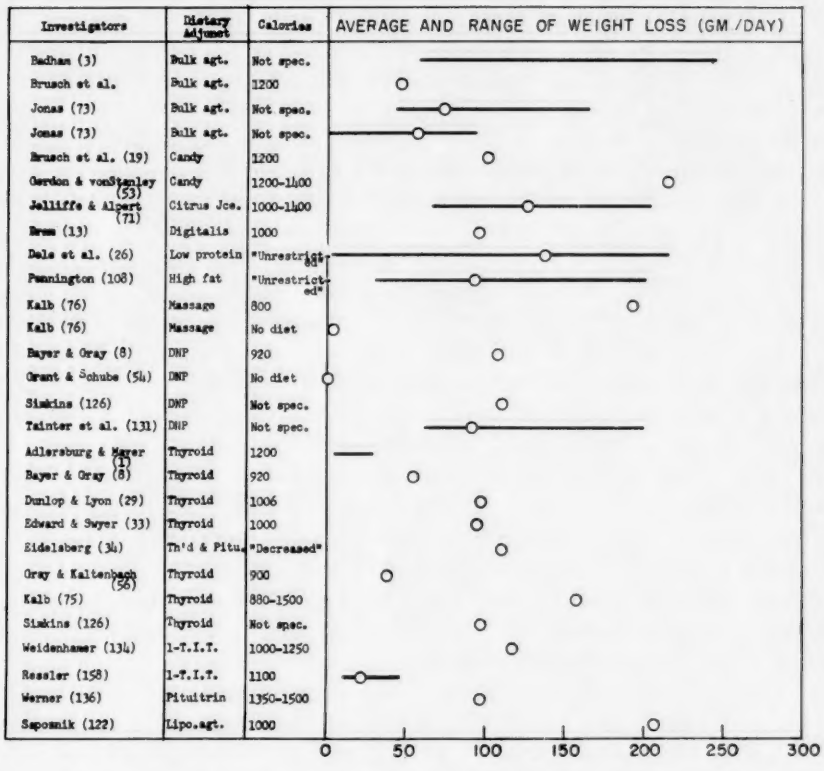
Investigators
Dietary Adjunct
Calories
AVERAGE AND RANGE OF WEIGHT LOSS (GM./DAY)
Badhan (3) Bulk agt. Not spec.
Brusch et al. Bulk agt. 1200
Jonas (73) Bulk agt. Not spec.
Jonas (73) Bulk agt. Not spec.
Brusch et al. (19) Candy 1200
Gordon & vonStanley (53) Candy 1200-1400
Jelliffe & Alpert (71) Citrus Jce. 1000-1400
Bram (13) Digitalis 1000
Dale et al. (26) Low protein "Unrestricted"
Pennington (108) High fat "Unrestricted"
Kalb (76) Massage 800
Kalb (76) Massage No diet
Bayer & Gray (8) DNP 920
Grant & Schube (54) DNP No diet
Simkins (126) DNP Not spec.
Tainter et al. (131) DNP Not spec.
Adlersburg & Mayer (1) Thyroid 1200
Bayer & Gray (8) Thyroid 920
Dunlop & Lyon (29) Thyroid 1006
Edward & Swyer (33) Thyroid 1000
Eidelsberg (34) Th'd & Pitu. "Decreased"
Gray & Kaltenbach (56) Thyroid 900
Kalb (75) Thyroid 880-1500
Simkins (126) Thyroid Not spec.
Weidenhamer (134) 1-T.I.T. 1000-1250
Ressler (158) 1-T.I.T. 1100
Werner (136) Pituitrin 1350-1500
Saposnik (122) Lipo.agt. 1000
0
50
100
150
200
250
300

Fig. 4.—Rates of weight loss for outpatient dietary programs, using various food restrictions and adjuncts to reduce appetite or alter homeostasis.

with DNP was shown by Grant and Schube.[54] They found no weight change in 13 men given DNP without a specific reduction diet.

(*4*) *Diuretics.* The use of diuretic techniques can produce prompt weight loss, although the change does not represent the desired loss of fat, but is due to excretion of water. The water, of course, is regained in nonedematous patients as soon as the diuretic therapy is stopped. (Diuretics are undoubtedly among the agents used occasionally by those physicians who refuse to divulge the contents of their "magical" injections for weight reduction.) The use of water and salt restriction or excretion for weight reduction in obese patients has little physiologic or clinical justification. Physiologically, the weight to be lost is surplus adipose tissue, not water. Clinically, the only patients who have had good results with these techniques[22,121,140] are those who simultaneously received caloric restriction. No large-scale studies with diuretics have been reported. In one group of patients,[46] vitamin C was used to promote fluid excretion. The authors noted that its usual dose was too small to create diuresis and concluded that it had "no effect" as an adjunct in weight reduction.

(5) *Hormones.* Hormonal agents became popular in the era when obesity was considered an endocrine disorder, and their use still persists in some areas. There are now ample data[100] indicating that almost no obese patients have any discernible primary hormonal imbalances and that any loss of weight associated with hormone treatment is due to the simultaneous use of caloric restriction. The most commonly used preparation has been thyroid; clinical results with it are shown in Table VI and Fig. 4. These data show the same variations found with other agents and the mean rates of weight loss range from the 39 Gm. per day in Gray and Kaltenbach's[56] group to the 156 Gm. per day reported by Kalb.[75] In all these studies, caloric restriction was applied concurrently. From time to time reports of other hormonal products have appeared. The reporting physicians have often implied that the hormones acted with a specific physiologic effect rather than merely as an adjunct which promoted adherence to the concomitant low-calorie diet. Using regular injections of Pituitrin, a 1,350 to 1,500-calorie diet, and thyroid, Werner[136] obtained a loss of 97 Gm. per day in 77 patients followed for 4½ months. The Pituitrin was used in the stated belief that it lowered plasma cholesterol after a fatty meal and might therefore act to mobilize lipid deposits. In a later test of the same regimen, Gelvin and McGavack[46] found that saline injections were as effective as Pituitrin.

Reiss[112] attained "good results" with lactogenic hormone in 8 patients who had "postlactational failure adiposity," but his report contained no numerical data. Simeons[125] claimed that injections of chorionic gonadotrophin had produced excellent results in diabetes, gout, hypercholesterolemia, and infertility, as well as in obesity. He stated that 500 obese patients, with daily intake restricted to 1,000 calories or less, had lost 250 to 600 Gm. per day while receiving chorionic gonadotrophin and suggested that the hormone helped mobilize fat from its depots. The data presented did not show how many of the 500 patients were hospitalized, what percentage had lost weight effectively, what results were obtained with placebo injections, or what specific evidence indicated the enhanced "mobilization of fat." No confirmation of these results has been reported. Using a "lipotropic" agent, Sapoznik[122] observed a weight loss of 206 Gm. per day in 14 patients who took a 1,000-calorie diet for 6 weeks. The data did not document the lipotropic effect of the drug. Lurie[89] described two boys who lost weight while receiving orally administered "pituitary extract." In a later analysis of this and other endocrine treatment for obesity, Bruch[17] demonstrated the absence of any physiologic efficacy for the drugs. Gray[55] and Kunde[84] have also reported instances of patients whose "endocrine" obesity responded well to dietary restriction alone.

Although isolated claims are still made for them, the various procedures intended to alter body homeostasis have not demonstrably shown any specific effects in reduction of adipose tissue. Good clinical effects found with them have almost always occurred together with a low-calorie diet from whose influence their own action could not be dissociated.

c. Mood alteration: Theories of an endocrine cause for obesity were gradually abandoned after a brilliant series of papers by Newburgh,[100-103] Bruch,[17,18,147-151]

and others which demonstrated the fallacy of the "endogenous" obesity concept. Into the temporary etiological vacuum, the psyche entered. Since the cause of obesity apparently was excess consumption of food, the latter presumably was due to psychic factors. The recognition of these factors in obesity has led to many psychodynamic interpretations and analyses of eating and feeding behavior. This approach has produced considerable knowledge and help in understanding certain obese patients, but its therapeutic utility has sometimes been limited. Individual psychotherapy has become used increasingly for obese patients, and excellent results have been reported as isolated cases[115] in the psychiatric literature. The only quantitative report of a series of such patients, however, is Rodger, McFetridge, and Price's[118] group of 64 who lost a mean of 68 Gm. per

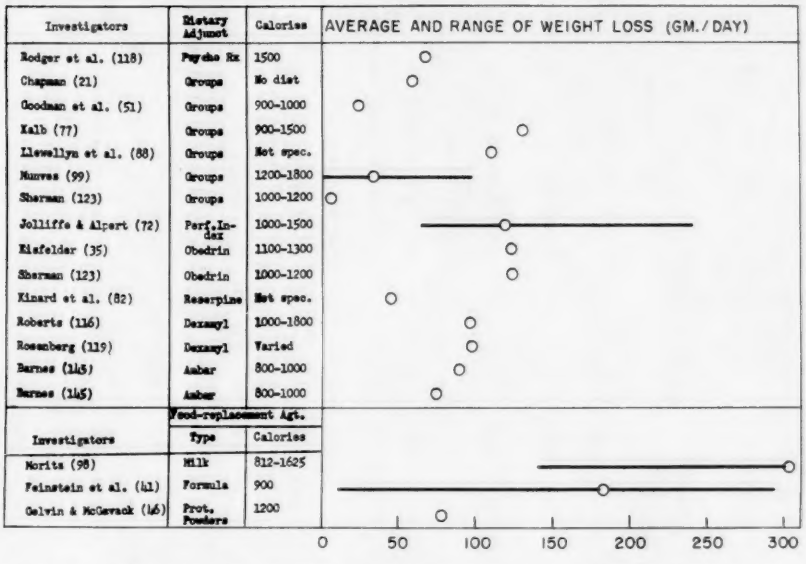

Fig. 5.—Rates of weight loss for outpatient dietary programs: results of regimens using various food restrictions together with mood-altering adjuncts; results of total food replacement.

day on a 1,500-calorie diet with individual dietary instruction and psychotherapy. Nicholson[104] has pointed out the advantages of psychotherapy for long-term maintenance of weight loss.

Regardless of how effective it may be in individual treatment, psychotherapy is not generally available. To reach more patients with this kind of technique, group meetings[21,51,61,62,77,88,99,123,127] have become commonly used. The results of these techniques, given in Table VII and Fig. 5, show the same marked variations observed with other treatment methods. The mean rates of weight loss range from 5 to 130 Gm. per day, and results have even varied widely with different groups of patients in the same clinic setting.[127]

Hypnosis, a psychotherapeutic procedure in which the major verbal communication is done by the therapist rather than by the patient, has had a current

TABLE VII. RATES OF WEIGHT LOSS FOR OUTPATIENTS USING MOOD ALTERATION AS A DIETARY ADJUNCT

INVESTIGATOR	AGENT	CALORIES	COMPOSITION (GM.)			GENERAL STATUS	NUMBER OF PATIENTS	DURATION: AVERAGE AND (RANGE) (MO.)	WEIGHT LOSS: AVERAGE RATE AND (RANGE) (GM. PER DAY)
			C	P	F				
Rodger, McFetridge, and Price[118]	Individual psychotherapy	1,500	—	—	—	Visited dietitian also	64	5	68
Chapman[21]	Groups	No specific amounts				20 weekly conferences	10	5	58
Goodman, Schwartz, and Frankel[51]	Groups	900-1,000	—	—	—	Diabetics; weekly meetings	33	(9-12)	24
Kalb[77]	Groups	900-1,500	—	—	—	Weekly meetings	?	(2½-3½)	130
Llewellyn and co-workers[88]	Groups	———	—	—	—	3 weekly meetings	77	¾	109
Munves[99]	Groups	1,200-1,800	—	—	—	Biweekly meetings	24	4	32 (0-96)
Sherman[123]	Groups	1,000-1,200	—	—	—	Controls; biweekly meetings	45	2	5
Winklestein[160]	Hypnosis	Caloric instruction				Specially selected	42	3½	108
Jolliffe and Alpert[72]	Special incentive	1,000-1,500	High protein			"Performance index" records checked regularly	44	(1-3)	119 (65-240)
Eisfelder[35]	Obedrin	1,100-1,300	70	60	70	Private patients	24	4½ (1-7)	122
Sherman[123]	Obedrin	1,000-1,200	—	—	—	Biweekly group meetings	53	2	123
Kinard and co-workers[82]	Reserpine plus amphetamine	No specific amounts				Obesity clinic	31	4	44
Roberts[116]	Dexamyl	1,000-1,800	—	—	—	Private and clinic	59	3	96
Rosenberg[119]	Dexamyl	Varied				"Carefully selected"	94	?	97
Barnes[145]	Ambar	800-1,000	—	—	40	Obesity clinic	27	—	88
Barnes[145]	Ambar	800-1,000	—	—	40	New group	50	(1-8)	75

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wave of popularity. The only available medical account[160] of its use in obesity reported an average weight loss of 108 Gm. per day for 14 weeks in 42 women who were specifically selected on the basis of their "ability . . . to enter a sufficiently deep trance state." The general applicability of hyponosis in weight reduction is uncertain since the report did not state what percentage of patients lacked this "ability."

A more informal psychiatric device has been the use of certain incentives to help promote dietary adherence. Some physicians have drawn graphs on which the weight curve is checked at each visit. Others have taken photographs which are compared at regular intervals. Jolliffe and Alpert[71] designed a "Performance Index" which checks the patient's actual weight loss against his expected loss. The patients who received this incentive lost a mean of 119 Gm. per day compared to 110 Gm. per day lost by another group on the same diet alone, although the total results in the "incentive" group were actually better than these comparative rates would indicate, as shown later in Table IX. Jenkins[70] tried to get group psychologic effects without actual group meetings by having his patients check their results against those of fellow dieters whose data were plotted on wall charts.

When "mood-altering" pharmaceuticals became available, it was inevitable that they would be applied to the treatment of obesity. Table VII shows the mean results with these agents: 44 Gm. per day with reserpine,[82] 96 and 97 Gm. per day with Dexamyl,[116,119] 122 and 123 Gm. per day with Obedrin,[35,123] and 75 and 88 Gm. per day with Ambar.[145] The only tranquilizer to have been reported thus far is chlorpromazine,[114] with which no specific rate data are cited except for a "good" or "fair" response in 6 of the 12 patients tested.

It is apparent that the over-all results with techniques which alter mood have not been more successful than those achieved with earlier methods. In individual cases, many significant performances have been obtained. Their general results with unselected obese patients, however, have been varied and the techniques have often failed.

B. No choice of food: With standard diets, the patient is responsible for selecting foods and limiting the size of their portions. The success or failure of the therapy is then dependent on how accurately the patient interprets the dietary prescription and how faithfully he follows it. In few other types of medical treatment is the "medication" taken with so many possible daily variations and with such lack of direct control by the physician. To prepare most regular food diets often requires complicated information about the calorie and "exchange" values of foods. Physicians may not be intimately familiar with these details or may not have enough time available for adequate instruction to their patients. Therefore the patient's prescription is often an impersonal, printed dietary form.

To check adherence to the diet is often impossible. Patients may be unable to measure the size of portions, may forget the foods eaten, or may find that certain items are not listed in caloric reference tables. Even when the patient keeps a careful written record of food intake, the physician cannot be certain of its accuracy because of the frequency with which many individuals engage

TABLE VIII. RATES OF WEIGHT LOSS FOR OUTPATIENTS ON DIETS INVOLVING NO CHOICE OF FOOD

INVESTIGATOR	AGENT	CALORIES	COMPOSITION (GM.)			GENERAL STATUS	NUMBER OF PATIENTS	DURATION: AVERAGE AND (RANGE) (MO.)	WEIGHT LOSS: AVERAGE RATE AND (RANGE) (GM. PER DAY)
			C	P	F				
Moritz[98]	Milk	812-1,625	Whole milk			Clinic	8	1 (¼-3)	345 (140-900)
Feinstein, Dole, and Schwartz[41]	Formula	900	85	22	52	Special clinic	106	4 (¼-19)	184 (12-1,023)
Gelvin and McGavack[46]	Protein powders	1,200	—	—	—	Allowed one meal of food per day	13	2	78

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in misinterpretation or self-deception. Confronted with no weight loss in a patient who pleads dietary fidelity, the physician has no easy method of confirming the history and often lacks the time for a critical inspection of its details.

In order to simplify therapy and enable the physician to prescribe more precisely, certain diets have been devised which eliminate the selection of foods by the patient. In most of these diets, food is entirely replaced by a nutrient mixture.

The earliest of these diets was whole milk, used by Karell in 1866 for renal, cardiac, and liver disease, and applied to 1 patient with obesity.[161] In 1908, Moritz[98] used 1¼ to 2½ L. of milk per day specifically for weight reduction in obese patients who took this as their only source of nutrients for almost 3 months. The weight losses in his 8 reported patients (Table VIII and Fig. 5) ranged from 140 to 900 Gm. per day with a mean of 345 Gm. per day. Harrop,[60] in 1934, described a 940-calorie diet of 1,000 ml. of skim milk and 6 large bananas, with which the losses were 130 to 409 Gm. per day for 2-week periods with an unspecified number of patients. Gelvin and McGavack[46] attempted a modified food-exclusion technique in which one meal of food was allowed per day and the remainder of a 1,200-calorie daily allotment was filled by protein powders dissolved in water. In 13 patients followed for 2 months, this diet produced a mean weight loss of 78 Gm. per day. The control group for the study took a standard 1,200-calorie food diet and showed a mean weight loss of 58 Gm. per day.

A large-scale study with a food-replacement regimen was reported by Feinstein, Dole, and Schwartz.[41] They gave 106 outpatients a 900-calorie formula mixture which had originally been devised for long-term hospital metabolic studies. It was adapted for home use after it was favorably received by the hospitalized patients. The weight losses in the "formula" outpatient group ranged from 4 to 629 Gm. per day, with a mean of 184 Gm. per day, for an average period of 4 months.

A new approach described by Baer[4] has not yet received clinical documentation. It allows the use of natural foods but rigidly controls them by a commercially packaged 1,100-calorie diet in which breakfast, lunch, and dinner foods are separately wrapped in a single container. No results of its use have been reported.

Despite the drastic nature of these substitution diets, some of the results have been dramatically good. The rates of weight loss reported in Moritz'[98] milk diet and in the formula diet[41] rank with the highest noted in the regimens described previously. Using other methods of measurement, as seen below, the total results with the formula diet have been as good, or better, than the other reported regimens.

OTHER METHODS OF EXPRESSING WEIGHT LOSS

The results of the preceding sections have been given as rates of weight loss because this unit of measurement has been most frequently used in the available literature. Other methods of expressing results may be more desirable. The criteria of Trulson, Walsh, and Caso[133] define success as the loss of a certain number

TABLE IX. "SUCCESS" PERCENTAGES USING TRULSON AND ABSOLUTE WEIGHT LOSS CRITERIA: PATIENTS IN RESTRICTED ENVIRONMENTS OR SELECTIVELY REPORTED

INVESTIGATOR	TREATMENT	TOTAL NUMBER OF PATIENTS REPORTED	PER CENT OF PATIENTS "SUCCESSFUL" BY TRULSON CRITERIA	PER CENT OF PATIENTS WHO LOST 20 POUNDS OR MORE	PER CENT OF PATIENTS WHO LOST 40 POUNDS OR MORE
Restricted environment					
Brown and Ohlson[16]	Nutritional table; 1,000 to 1,200 calories	8	100	88	13
Leverton and Gram[87]	Nutritional table; 1,200 calories	12	83	58	0
Young[141]	Nutritional table; 1,400 calories	10	60	40	0
Young, Ringler, and Greer[143]	Nutritional table; 1,400 calories	6	83	50	0
Moller[97]	Hospitalized; 950 calories	46	—	35	7
Young and co-workers[144]	Men at nutritional table; 1,800 calories	8	63	75	0
Unrestricted environment: Total number exposed to diet not reported					
Eisfelder[35]	Private patients; 1,100 to 1,300 calories; Obedrin	24	83	79	21
Hirsh[65,66]	Private patients; 1,000 calories; phenylpropanolamine	12	50	58	8
Jolliffe and Alpert[72]	Private patients; controls; 1,000 to 1,500 calories	44	16	9	0
Jolliffe and Alpert[72]	Private patients; 1,000 to 1,500 calories; performance index checked	44	30	20	0
Jenkins[70]	1,000 calories; amphetamine; wall charts	87	—	41	?
Jonas[73]	Specially selected patients; no special diet; bulk agents	20	60	65	10
Lesses and Myerson[86]	Private patients; 1,400 calories; Benzedrine	17	59	41	12
Moritz[98]	812 to 1,625 calories; milk only	8	25	38	13
Pelner[107]	Private patients; ? diet; Benzedrine	6	100	100	33
Pennington[108]	High fat; "unrestricted" calories	20	20	40	10

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of pounds, depending on the initial weight. Thus a patient who originally weighs 150 pounds must lose at least 10 pounds to be "successful"; one who weighs 160 pounds must lose at least 15 pounds; etc. Another method of expressing dietary performance is to select an arbitrary level of weight loss, such as 20 pounds or 40 pounds, and to note what percentage of the starting patients achieved these results. Neither of these techniques is entirely satisfactory for the estimation of dietary success.[40] Except for rates of weight loss, however, there are no other methods of expression for which enough reported data can be found to warrant tabulation.

Tables IX and X list the 35 reports in which the data could be evaluated by these two parameters. Whenever an outpatient report cited the total number of patients starting treatment, the results are listed in Table X as a percentage of this number. In numerous papers, the total number of patients who started treatment was not reported and these reports have been itemized in a separate portion of Table IX, together with the results of diets used in restricted environments.

Table IX shows that the patients dieting in restricted environments consistently attained high results as measured by the Trulson criteria and by absolute weight loss. No dietary adjuncts were used in these groups and the food diets were 900 to 1,400 calories with the differences in composition indicated in Table II. Since these patients dieted in the controlled environments for relatively short periods of time, it is not surprising that only small percentages lost over 40 pounds and that there is large variation in the frequency of patients who lost over 20 pounds.

The results in the second section of Table IX are difficult to interpret. When authors give data for a number of patients but fail to list the total number who began the diet, it is quite likely that only the most successful cases have been reported. For example, Jolliffe and Alpert[72] state that their data include "only patients who were observed for four consecutive weeks or longer." Patients who do not return for further observation have generally stopped their diet and must be considered failures. When the data of these latter patients are absent from the total statistics, a falsely high value is attributed to the reported results. Therefore, no further analysis can be given these data, other than to note the many instances in which these results from selected successful patients are inferior to some reported in Table X, where all of the patients were recorded.

Probably the most useful reports of dietary effectiveness are those given in Table X. In these data, all of the starting patients are accounted for and the regimen was taken under outpatient conditions. Using the Trulson criteria for measuring success, the results in seven reports ranged from 14 per cent to 28 per cent. All but one of these seven regimens used regular food diets. The different adjuncts employed were anorexiants,[63,113] citrus juice,[71] group meetings,[99] or nothing.[133,142] In one of these, no special diet was used but the patients received a tranquilizing agent.[114] The other reports show that in Ressler's[113] group of clinic patients on an 1,100-calorie diet (who served as controls for a simultaneous test of phenmetrazine), none was successful. Using the formula diet, 56 per cent of the patients of Feinstein, Dole, and Schwartz[41] achieved success. This is the highest result reported for any large-scale dietary study. In a small, carefully selected

TABLE X. "SUCCESS" PERCENTAGES USING TRULSON AND ABSOLUTE WEIGHT LOSS CRITERIA: PATIENTS IN UNRESTRICTED ENVIRONMENTS AND TOTALLY REPORTED

INVESTIGATOR	TREATMENT	TOTAL NUMBER OF PATIENTS REPORTED	PER CENT OF PATIENTS "SUCCESSFUL" BY TRULSON CRITERIA	PER CENT OF PATIENTS WHO LOST 20 POUNDS OR MORE	PER CENT OF PATIENTS WHO LOST 40 POUNDS OR MORE
Barnes[145]	800 to 1,100 calories; Ambar	50	—	34	8
Bauman[6]	1,200 calories; occasional thyroid	183	—	23	?
Beck and Hubbard[9]	Clinic; 840 calories food	46	—	59	17
Feinstein, Dole, and Schwartz[41]	900-calorie formula as food replacement	106	56	59	31
Fellows[42]	Instruction and self-selection of diet	294	—	26	5
Gray and Kaltenbach[56]	Clinic; 900 calories food	314	—	28	7
Gelvin and McGavack[47]	Clinic; no special diet; Dexedrine	30	—	13	?
Hawirko and Sprague[63]	Private patients; 1,100 calories; Dexedrine or Benzedrine	162	28	28	5
Jolliffe and Alpert[71]	Special friends; 1,000 to 1,500 calories food	11	73	55	0

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Jolliffe and Alpert[71]	Private patients; 1,000 to 1,400 calories; citrus juice	73	18	11	0
Harvey and Simmons[68]	1,000 calories; weekly group meetings	290	—	23	?
Munves[99]	Special interviews or groups; 1,200 to 1,800 calories	48	19	8	0
Osserman and Dolger[105]	Diabetics; 1,000 calories; amphetamine	55	—	29	2
Ressler[113]	Clinic; controls; 1,100 calories	16	0	0	0
Ressler[113]	Clinic; 1,100 calories; phenmetrazine	14	14	14	7
Ressler[114]	? Diet; chlorpromazine	12	17	33	0
Ressler[158]	Clinic; controls; 1,100 calories	13	—	0	0
Ressler[158]	Clinic; 1-Triiodothyronine; 1,100 calories	13	—	8	0
Stunkard and McLaren-Hume[159]	Nutrition clinic; 800 to 1,500 calories	100	—	12	1
Trulson, Walsh, and Caso[133]	Nutrition clinic; various diets	847	23	—	—
Young and co-workers[142]	Nutrition clinic; various diets	156	26	28	3

sample of 11 patients who were also personal friends, Jolliffe and Alpert[71] found success in 8 (73 per cent), using food diets of 1,000 to 1,500 calories and weekly checks with the "performance index."

The data of Table X also show results in which a loss of 20 pounds or more was used as a criterion of success. Values of 0 to 14 per cent were found in eight reports and 23 to 34 per cent was reported following nine other dietary regimens which employed a variety of techniques and adjuncts. Only three noted a higher incidence of success. One of these was Joliffe and Alpert's[71] group of 11 special friends, of whom 55 per cent lost over 20 pounds. In the other two reports, 59 per cent of the starting patients lost over 20 pounds. This occurred in Beck and Hubbard's[9] group of 46 clinic patients on an 840-calorie food diet and in Feinstein, Dole, and Schwartz's[41] 106 clinic patients on a 900-calorie formula diet.

A more stringent criterion of success is the loss of 40 pounds or more. The use of this large a value demands that the patients usually will have dieted for at least 2 months and that they be initially more obese than many "esthetic" dieters who are not markedly overweight, whose motivation in weight reduction is almost always cosmetic, and who often make up the major clientele involved in quick reduction schemes.[40] In fifteen of the seventeen reports of Table X for which the data on loss of 40 pounds are available, less than 8 per cent of the starting patients lost this much and in five groups, none of the patients did so. The highest results with the 40-pounds criterion were in the previously described groups of Beck and Hubbard and of Feinstein, Dole, and Schwartz, where this was achieved by 17 per cent and 31 per cent, respectively, of the starting patients.

A review of the data in Tables IX and X confirms the concept that environmental restriction, regardless of the composition of the diet, is a consistently successful method of producing weight loss. For the general outpatient environment in which most obese patients are treated, results have varied. The four separate groups reported by Jolliffe and Alpert[71,72] illustrate the issues well. In all four sets of their patients, the diets employed were essentially identical. The two groups of patients reported in Table IX differed from each other only in that one group received the additional incentive of having their weekly performance specifically checked against the anticipated result by the "performance index." This group was approximately twice as successful as its "control" (30 per cent versus 16 per cent successful by Trulson criteria; 20 per cent versus 9 per cent who lost over 20 pounds). The two sets of Jolliffe and Alpert's patients reported in Table X differed in that one group had been carefully selected while the other was a random sampling of obese patients. (The citrus juice taken preprandially by the latter group may be considered of minor importance.) The results of the selected group were four to five times better than those of the unselected patients (73 per cent versus 18 per cent successful by Trulson criteria; 55 per cent versus 11 per cent who lost 20 pounds or more). In the other reports of Table X, no specific selection of obese patients was used. The most spectacular results with unselected patients are those given by Feinstein, Dole, and Schwartz for the 900-calorie formula diet. These authors did not test a control group on a 900-calorie food diet and believed that other features of their program, in addition to the formula itself, played important roles in the success achieved by

their patients. That the formula diet per se was not the main factor in these results is shown by the fact that Beck and Hubbard's patients did almost as well on an 840-calorie diet of regular foods. Natural food diets were used in the other programs reported in Table X, and many were aided by various adjuncts. Nevertheless, the over-all results of these regimens were inferior to those with the two groups cited above in which only caloric restriction was used.

SIDE EFFECTS OF WEIGHT REDUCTION

Food has always been known as one of mankind's "oldest and greatest sedatives."[95] The removal of this sedation from a dieting patient would be expected to produce certain symptoms of anxiety, tension, or depression. Among these symptoms[106] can be headaches, palpitations, nausea, diarrhea, lethargy, tachycardia, hunger, giddiness, weakness, fatigue, irritability, faintness, dry mouth, etc. These symptoms are generally considered of functional origin and are frequently seen in many patients who are not on weight-reduction programs. Yet, when these symptoms appear in a dieting patient they are almost always attributed to the adjunct medications or to the diet itself.[128] Occasionally, the symptoms have been considered due to hypoglycemia,[53,58] although no corroborating blood sugar values have been cited. The fallacy of assuming that all dietary side effects are caused by the concomitant drugs was well demonstrated by Kalb[75] and Barnes[5] who found a high incidence of symptoms in control groups. Many other reports have described the "side reactions" encountered in dieting but have not offered controlled studies or other evidence to prove that the diet had caused the symptoms. In many instances, patients were thought to have abandoned certain dietary regimens because the program itself had created unpleasant reactions. Consideration has seldom been given to the alternative hypothesis[128] that the absence of food sedation has evoked symptoms which the patient and doctor have then attributed to specific qualities of the diet or the medication. In an excellent analysis of the entire problem, Stunkard[130] has pointed out the frequency with which symptoms appear when obese patients diet, regardless of what treatment is used, and has noted the poor documentation given in most descriptions of the incidence of these side reactions. The analysis of these symptoms is further complicated by the fact that many of them are often present in patients *before* the diet is begun and may disappear with successful maintenance of the diet.[41]

The available evidence suggests that when a patient begins to restrict calories, the deprivation of food may evoke certain anxiety symptoms which occur regardless of the type of diet or medications employed. If these symptoms are suppressed and the patient adheres to the diet, the accomplishment usually creates a feeling of elation which further minimizes the symptoms. This relative euphoria either persists and the patient continues to diet successfully, or it starts to disappear. As it disappears, the craving for food returns, side reactions appear or reappear, and the diet is abandoned.

Because the side effects have not been thoroughly documented, the preceding analyses of dietary results have not considered such effects as part of the criteria for "success."

COMMENT AND CONCLUSIONS

"If event B follows event A, then event A has caused event B." This *post hoc, ergo propter hoc* reasoning has occurred in all forms of human activity. Medically, it has often been used to conclude that preceding treatments were necessarily responsible for observed clinical results. Obviously, such faulty reasoning has occasionally led to erroneous deductions. In order to avoid the errors of fallacious therapeutic conclusions, increasing attention has been given to controlled experiments. However, these scientific techniques have not yet been used to test many old theories which, unsupported by rigorous proof, continue to govern therapeutic approaches in many branches of medicine.

In particular, many of the current concepts of treatment in obesity appear to be the product of *post hoc, ergo propter hoc* reasoning. In repeated instances the successful loss of weight by a patient has been attributed exclusively to a selected feature of the therapeutic program. When patients failed to lose weight or abandoned the program, they were dismissed as "uncooperative" and their results were ignored. The removal of these patients from the data left a limited number of successful performances, from which it was deduced that the dietary regimens had particularly good therapeutic properties. Certain beliefs have thus been developed and transmitted to succeeding medical generations and have achieved the secure status of tradition.

Among these beliefs are the concepts that there exists an "ideal" diet for weight reduction, that this diet should be "balanced," that it should give the patient nutritional instruction, that it should have a "high" protein content, and that various types of adjuncts can be effectively used to regulate the patient's appetite, mood, or shape.

These recommendations are supported by considerable theoretic and experimental evidence and they have been confirmed in countless individual experiences. However, the totality of clinical data demonstrates that many of these "desirable" features have been far more attractive to the nutritionist, physician, or layman who designed the program than to the patient who was to follow it. In every completely reported dietary program, the percentage of failure is far greater than that of success. Weight reduction regimens may thus be optimal according to experimental and theoretic standards but may fail to show any value when actually used on patients.

The very existence of the "obesity problem," the multiplicity of different available diets and dietary adjuncts, the many relapses following apparently "successful" therapy, the absence of adequate standards for measuring success—these have all made it apparent that no described dietary program has been clinically ideal and that reports of success with many diets have been based on incomplete appraisals of the results.

From the data which have been classified and tabulated here, two immediate observations can be made:

(1) The obese patient whose food intake is controlled and imposed by environmental restriction will lose weight well regardless of the constituents of

the diet, and the amount of weight loss will be directly proportional to the amount of caloric deprivation.

(2) For outpatients, who are free to maintain or reject the prescribed diets, no reported diet or dietary adjunct has been consistently successful. Conflicting and markedly contrasting results have occurred with identical diets used by different physicians, with different diets used by the same physicians, and with isocaloric changes in the form and composition of dietary ingredients.

In many instances, these different results may be due to the inadequacy of the criteria used for measuring dietary accomplishment or may vary with the length of time used for the study and the percentage of patients whose results were reported. These may be the factors responsible for much of the variation seen in Tables III to VIII. However, the same variation is also present in the results of Table X, where different methods were used to define accomplishment, thereby eliminating many of the above features. Thus, the results show many inconsistent and random variations, regardless of the criteria used for measurement. This suggests that the differences arise from factors other than those employed in the tabulations.

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An explanation of these phenomena is contained in the following conclusion which emerges from them: Adherence to a dietary program and the consequent weight reduction occur as a result of the interaction of three sets of factors which are intrinsic to (1) the patient, (2) the therapeutic relationship, and (3) the dietary program itself. Each set of factors contributes an incremental effect whose size and nature will vary in individual patients. If any one of the factors is sufficiently negative, it can overcome the positive effects of the others and the final result will be negative. The features and interaction of these factors are further described below.

1. Factors Intrinsic to the Patient.—It is beyond dispute that no diet can work unless the patient follows it. Yet the amount of time and thought given to the preparation and description of a nutritionally desirable diet is usually far greater than the attention given to the status of the patient who must maintain it.

This status can be influenced by the degree of obesity, the patterns by which the excess weight has been acquired, the age, the conscious and subconscious motivation, the home and work environment, and the entire panorama of factors[18,44] which create, alter, and gratify the human psyche. There are many different psychic responses[153,154] to food and the act of eating. Although food is recognized as a sedative,[95] its "dosage" and the features under sedation can have a wide range of variation. The patient will react to withdrawal or reduction of this sedation according to the degree of his dependency and habituation to it.

In this respect, obese patients may be divided into a numerically small group who have no difficulty in changing their patterns of eating and a second group, the overwhelming majority of patients, who cannot easily do so. Patients in the firstgroup are able and willing to reduce food intake but do not know how to do it. Their true problem is ignorance of the caloric values of foods. They lose weight well as soon as they learn what to eat. Most obese patients, however, are in the second group. They know the caloric content of foods and know what

not to eat. Their problem is that they cannot resist eating it. The further education of these patients in nutritional concepts may implement their caloric knowledge, but it seldom results in sustained weight loss. For these individuals, the major difficulties are motivation to begin a diet, determination to continue with it, and the resolution to maintain the achieved weight loss.

Patients in this category may be further divided into two subgroups. The first set of patients may require formal psychiatric assistance. This is usually necessary for the truly "compulsive eaters" and the psychotic or severely neurotic obese patients whose psychic disturbances would have brought them to psychiatric attention regardless of the associated obesity into which they have often diverted their problems. The second set of these two subgroups probably constitutes the majority of overweight patients. They neither are ignorant of food values nor do they have severe psychiatric disturbances. They seem to be a random segment of a neurotic human population who happen to have become overweight and who are unable to deprive themselves of enough food for a long enough time to become and remain reduced. Their need for food can have numerous features which do not fit a single psychiatric explanation. Their need for psychiatric assistance will vary as with any random sampling of population.

Some of the patients in this latter group may never be able to lose weight. Others may achieve the necessary motivation and resolution through changes in their personal and interpersonal life situations. For example, the rebellious adolescent, arrived at adulthood, may no longer use food for the purpose it served during his younger years. The matron whose pregnancies are completed, whose children are grown, and whose life has become stable may have reached a certain adjustment which allows her to tolerate a reduction in food intake. The middle-aged executive whose colleague has had a recent myocardial infarction may be sufficiently frightened to maintain a diet. When the new motivation has already been internally acquired, the patient is prepared for the dietary procedure. It is clear that many instances of "success" reported in such internally motivated patients have been incorrectly attributed to a specific diet and its adjuncts, when actually the results would have been just as good with almost any regimen that provided caloric restriction.

Many other obese patients, however, may not be able to induce their own motivation. For some of these patients, an external source may be a decisive factor.

2. Factors Intrinsic to the Physician-Patient Therapeutic Relationship.—A doctor's attitude and behavior obviously can affect a patient's general state. Physicians were performing this role in the treatment of disease long before the activity was labeled as "psychotherapy." Yet, the effect of the physician as a therapeutic agent often is not considered in evaluating the treatment of obesity. Nevertheless, when different physicians get different results using identical dietary regimens, it is apparent that they have disagreed either in their standards of patient selection, in their criteria for measuring results, or in judging the effect of their own contributions to the therapy. If the patient selection and measurement criteria are constant, the variable in question must be the physician himself.

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There are numerous specific ways in which the physician can contribute to the treatment of obese patients. He is generally aware of only one particular role: his regulation of the medical aspects of the diet and its adjuncts. But he also can have many other functions: (a) as an objective "watchdog" to whose scale and inquiries the patient regularly returns, (b) as an investigator who determines the existence and nature of dietary indiscretions and the true cause of concomitant symptoms, (c) as an informal psychotherapist to whom the patient ventilates and from whom the patient receives support, sympathy, reprimand, or encouragement, and (d) in a variety of additional ways which have been described elsewhere.[153] He may be punitive, moralizing, gently persuasive, or firmly demanding.

The physician may not consciously recognize or accept his role as a therapeutic agent. Whether he does it deliberately or not, his participation is an active part of the treatment and, in certain patients, his influence may provide the increment of motivation, determination, or resolution that helps sustain the dietary effort.

Certain aspects of the physician's contribution to dietary programs are often left unspecified. They are:

(a) *The frequency with which the patient is seen:* In the return visits the patient feels the responsibility of being checked and the physician can perform the various functions described above. Some of the effects which have been attributed to injections or specially dispensed medication undoubtedly derive from the fact that the patient returns at frequent intervals to receive them.

(b) *The availability of the clinic:* Many institutions do not maintain evening clinics. Since most obese patients do not regard their condition as a serious disease, they will not take time from work or home to attend the clinic during daytime hours and, hence, will not receive the assistance of a physician. The success percentages in public clinics are almost always lower than those of private practitioners. This may be due more to the flexibility of the practitioner's office hours than to any difference in his techniques or his clientele.

(c) *The incentives offered by the physician:* In addition to his comments of approval or disapproval, the physician can supply visual material for incentive and motivation. Among the available techniques are computation of the "performance index," wall chart comparisons with other dieters, sequential photographs, and graphs of the curve of weight decline.

(d) *The physician's general attitude:* Many doctors regard the obese patient as a neurotic nuisance and the diet treatment as a complicated bore. They dismiss obese patients with a few general admonitions, a printed list of foods, and a medication. Seldom does a physician give an obese patient's diet problems the attention that might be applied to regulating insulin for patients with diabetes or diuretics for those with heart disease. In some situations, a physician's leadership may be completely absent and the therapy may be supervised by a dietitian, group leader, masseuse, or woman's magazine columnist. The emergence of so many nonmedical individuals as guides in the treatment of obesity has been due in part to the large popular demand and in part to the disinterest and apathy of many physicians. When these lay "therapists" have adequate perception of

biologic and human reactions, they can perform this role quite capably, and in many instances, they have been more effective than physicians. At other times, their lack of medical qualifications may have led to unfavorable results or consequences. Regardless of whether or not the director of treatment is a physician, his personal properties make major contributions to the patient's progress. In certain situations the absence of this particular therapeutic stimulus is decisive.

The above comments do not necessarily imply that successful or unsuccessful dietary performances are due to the physician-patient relationships. In some of the data which were cited earlier, good or bad results may be due to other features, such as patient selection, properties of the diet program, or methods of measuring accomplishment. However, when these other features are controlled and the results are still diverse, the disparities almost certainly arise from the therapeutic effects of individual physicians.

It is evident that more effective participation by physicians cannot solve the existing problems in obesity. If the factors intrinsic to the patient are sufficiently negative, they often cannot be overcome by a physician, or even by a psychiatrist. However, the existing data repeatedly have indicated the importance of the physician's role in the treatment of obesity. The inference is plain that certain obese patients, who would otherwise fail, may be significantly helped by this kind of therapy.

3. Factors Intrinsic to the Diet Program.—The data have clearly shown that patients will lose weight if they restrict caloric intake adequately. The exact form and composition of this limited intake do not seem to be of critical importance. Successful outpatient dietary performances have not consistently correlated with the exact number of prescribed calories, the protein or fat content of the diet, the use of natural food as compared to a nutrient mixture, or the kinds of medicinal or other adjuncts which have been employed.

The attainment of success appears to depend more on the features which make the patient adhere to a dietary program than on the specific structure of the program itself. The factors which promote dietary adherence are influenced, as described above, by the patient's own status and by the nature of his therapeutic relationship. These are the factors which account for different results observed with the same diet.

These features can also be indirectly responsible for the success of new diets and dietary adjuncts. Each new pill, injection, vibrator, or menu finds its way to many physicians and patients who hopefully await some new approach which will avoid the failures of the old. The very novelty of the "latest" preparation can arouse an enthusiasm in both physician and patient which then creates adherence to the dietary program. If the physician genuinely believes in the effectiveness of a dietary adjunct or if he finds that a new, radical diet can be administered and checked with simplicity, these features can give him a positive feeling which is communicated to the patient and which may significantly affect the patient's maintenance of the program. *Post hoc, ergo propter hoc* reasoning then attributes the successful performance to specific components of the new regimen rather than to its more effective feature: the enthusiasm which its novelty

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created. With time, many patients begin to lose their inital enthusiasm and can no longer tolerate the lack of sedation by food. They resume their former eating habits, the dietary program is said to have lost its effectiveness, and it is cast aside as a failure. The patient then waits for the next new technique, and the cycle begins again.

These considerations lead to the inevitable conclusion that the actual construction of the diet and the nature of dietary adjuncts are themselves of little importance in a successful weight reduction procedure. When the patient is really ready to diet, he can lose weight with whatever method of caloric restriction is given him. New diets or dietary adjuncts frequently have a psychologic effect which helps dietary adherence rather than a specific nutritional, hormonal, or metabolic action. The patient is helped to begin or continue the process by the care and attention of an interested therapist. When a physician participates, his role is to use his own therapeutic properties, to select any dietary adjuncts which may be helpful, and to choose for the patient a diet which will be comfortable and effective. In most instances, a traditional standard food diet is the preferred agent. For other patients, particularly those who have had repeated failures with standard approaches and medications, a new approach may be worth while. Diets which permit the use of only a small variety of foods or more radical procedures, such as drastic caloric restriction or use of a food-replacing nutrient mixture, have at times been far more successful than the standard diets. These alternative approaches have been effective weapons in the therapeutic armamentarium against obesity and should not be excluded merely because they deviate from nutritional tradition.

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SUMMARY

The available results of treatment in obesity have been tabulated and analyzed. The dietary programs were classified according to the techniques used for weight reduction. These include environmental control, caloric restriction using natural foods, total replacement of foods by nutrient mixtures, and the use of various dietary adjuncts intended to depress appetite, change body homeostasis, and/or create mood alteration. The data were examined according to the three most commonly used methods of expressing dietary accomplishment: (1) rates of weight loss, (2) criteria of Trulson, Walsh, and Caso, and (3) percentage of starting patients who lost 20 pounds and/or 40 pounds.

Analysis of the results was difficult because of deficiencies of the criteria used for measuring performance and because of inconsistencies in methods of reporting results. When reasonable comparisons could be made, the data showed that complete restriction of environment (usually to a hospital) produced a consistent weight loss which was directly proportional to the amount of caloric deprivation. In the uncontrolled, outpatient environment, no reported diet or dietary adjunct was predictably successful. Identical dietary programs had markedly different results when used by different physicians. Newer dietary adjuncts frequently had results worse than those produced by their predecessors. Drastic caloric restriction or diets radically different from traditional nutritional

concepts were sometimes associated with remarkably high rates of accomplishment, while standard approaches occasionally had large percentages of failure.

The variety and inconsistency of these results indicate that many nutritional, pharmaceutical, and other theories of weight reduction have not been clinically verified and appear to be the result of fallacious reasoning. In the absence of confirmatory controlled studies and with inadequate techniques for measuring accomplishment, "successful" performances in weight reduction have been attributed only to features of the diet or dietary adjuncts. Whenever complete results have been given for dietary programs, the data have shown that more patients fail than succeed.

These results permit the conclusion that weight reduction involves the interaction of three sets of factors, which depend upon (1) the patient himself, (2) the therapeutic relationship, and (3) the dietary program. The individual influence of these factors will vary with each patient, and in a majority of instances, the dietary program is the least important of the three. The problem is not a lack of suitable diets or dietary adjuncts but the patient's inability to adhere to the prescribed program. This adherence is far more dependent upon the patient's intrinsic personal or external therapeutic factors than upon specific properties of the dietary regimen. The patient's personal reactions to food restriction are manifold and not easily changed. If these reactions are sufficiently negative, no program can be successful. Although formal psychotherapy may sometimes be useful, it is unavailable for most individuals who are trying to lose weight. Some help can be obtained from the therapeutic effect of the physician (or layman) who directs the dietary program. This effect can be achieved by various tangible and intangible approaches which are not specifically psychiatric.

Although these conclusions appear self-evident, they have not been previously evaluated with quantitative techniques. Nondietary factors in weight reduction have been regularly ignored or unmeasured in assessing the results of obesity programs and illogical conclusions have then assumed that successful performances arose only from features of the dietary program. Consideration of all the involved factors has shown that the actual structure of the diet is of little importance as long as the patient and physician are comfortable with it. Standard food diets and adjuncts are traditionally established, generally acceptable, and the first choice with most patients. Since their use is often followed by failure, new techniques are constantly being sought and devised. The novelty of some of these approaches may sometimes evoke from the patient and physician an enthusiasm which helps the patient maintain the diet. Thus, in prescribing for an overweight patient, the physician can select from a large variety of dietary programs and adjuncts. This choice, and the interpretation of its results, should be made with full recognition of all contributing factors and not merely based on experimental nutritional and pharmacologic theories.

These features suggest that higher percentages of success might be obtained in the treatment of obesity by less rigid devotion to concepts of diets, drugs, and devices and by more flexible attention to the total status of the dieting patient.

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FACTORS INFLUENCING THE PROGNOSIS OF CEREBRAL THROMBOSIS AND INFARCTION DUE TO ATHEROSCLEROSIS

NOBLE J. DAVID, M.D., AND ALBERT HEYMAN, M.D.

DURHAM, N. C.

From the Department of Medicine (Neurology Division), Duke University Medical Center, and the Durham Veterans Administration Hospital

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LONG-TERM anticoagulant therapy, low-fat dietary management, and surgery of the cerebral vessels are being regarded with increasing enthusiasm in the treatment and prevention of cerebral infarction due to arterial thrombosis. The value of such therapeutic and prophylactic measures, however, is difficult to assess since there is little information available as to the natural course of cerebral infarction, i.e., the frequency of recurrence and mortality. Several studies are concerned with immediate prognosis[1,2,3] or the late mortality of patients with selected areas of thrombosis such as carotid occlusion[4] and brain stem infarction.[5] To our knowledge, however, only 3 long-term studies have been published on the survival of a large number of patients with cerebral thrombosis and infarction.*In one of these, Pincock[6] made observations on 101 Canadian war veterans surviving the initial effects of cerebral infarction and found a 55 per cent mortality rate in the ensuing 7 years. This incidence of mortality was approximately that occurring in the normal population of the same age group. In the second study, Lindgren[7] noted a 34 per cent mortality rate within 2 years in a group of 65 relatively young patients (average age, 42.7 years) who had thrombosis or embolism involving either the carotid or middle cerebral arteries. Most of the deaths in Pincock's series were caused by atherosclerotic heart disease. The mortality resulting from recurrent cerebral vascular disease was actually less than would be expected in the general population. In the most recent study,[8] however, which consists of a life table analysis of survival of more than 1,000 patients with cerebral thrombosis, there was a 5-year mortality of 59 per cent, which was about two and one-half times that of the general population. Practically all of the reports on this subject consist of a retrospective review of

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*Since this paper was submitted for publication, our attention has been directed to an additional study[18] of the prognosis of cerebrovascular disease.

hospital records. Complete follow-up observations in such investigations are usually not possible, since many patients are lost to the study and information as to their outcome cannot be obtained.

The present report summarizes our experience with 100 consecutive patients with cerebral infarction or ischemia caused by atherosclerosis, who have been observed for 2 years following their cerebrovascular episode. An attempt is made to correlate morbidity and mortality rates with such factors as age, degree of hypertension, coronary artery disease, the location of the cerebral infarction, and other aspects of the illness.

CASE MATERIAL AND METHODS

An examination, by one of the authors, was made of each patient with evidence of a cerebrovascular disorder entering Duke University Hospital or the Veterans Administration Hospital in Durham during an 8-month period from January, 1957, to September, 1957. The first 100 consecutive patients with evidence of cerebral infarction or ischemia caused by atherosclerosis were entered in this study. Each patient had routine skull x-rays, spinal fluid studies, and, when possible, electrocardiographic and electroencephalographic examinations. In a few instances arteriograms were made of the cerebral vessels. Only patients having new or progressive symptoms within 2 months prior to admission were included in the study. All patients suspected of having cerebral hemorrhage, or cerebral embolism, as well as those with evidence of neurosyphilis, sickle-cell anemia, polycythemia vera, or collagen disorders were excluded from the study.

The case material consisted of 62 white men, 6 white women, 28 Negro men, and 4 Negro women. The high percentage of white patients corresponds to that of the admission rates of the two hospitals. The large number of males is due in part to the inclusion of case material from the Veterans Administration Hospital. Among the 36 patients seen at Duke Hospital, however, only 10 were women—a finding consistent with other observations that cerebral infarction occurs more frequently in males.[7,9] The mean age was 57.3 years. There was no correlation between the age of the patients and their sex or race. The age incidence by decades was as follows: 7 patients were between 26 and 39 years; 14 between 40 and 49 years; 24 between 50 and 59 years; 50 between 60 and 69 years; and 5 over 70 years. The 7 patients in the 26 to 39 age range were presumed to have atherosclerotic thromboses, despite their comparative youth and the absence of hypertensive cardiovascular disease or diabetes.

Fifty of the 100 patients in this study had either persistent elevation of blood pressure (150/100 or more) during their hospitalization or gave a reliable history of long-standing blood pressure of this magnitude. Fifteen of these 50 patients were considered to have severe hypertensive disease on the basis of grade 3 or 4 retinopathy (Keith-Wagner criteria) or evidence of cardiac or renal failure.

An electrocardiogram was made in 85 of the 100 cases. Thirty-seven of these 85 patients (44 per cent) had definite ECG abnormalities indicating myocardial infarction, myocardial ischemia, ventricular hypertrophy, or disturbances of

rhythm such as atrial fibrillation or flutter. Patients with such ECG abnormalities as questionable ventricular ischemia, extrasystoles, and digitalis effects were classed with those having borderline or normal records. Diabetes was present in 8 of the 100 patients. Twelve others had convulsive seizures at the onset of their stroke or subsequently, only 2 of whom had had antecedent seizures.

The general location of the infarction within the brain was determined whenever possible using the criteria of the *ad hoc* committee of the Advisory Council to the National Institute of Neurologic Disease and Blindness.[10] In 48 patients the site of the infarction or ischemia was considered to be in the territory of the carotid artery; in 32 patients the vertebral-basilar system was involved; and in the remaining 20 cases the location could not be determined with certainty. Nine of the 48 patients with lesions in the cerebral hemispheres were diagnosed as having thrombosis of the carotid artery on the basis of arteriograms or retinal artery pressure determination.[11] Twenty-three patients had a history of previous cerebral infarction, only 13 of whom had signs of pseudobulbar palsy or bilateral cerebral damage.

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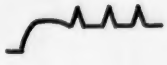
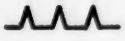
Table I depicts the mode of onset of cerebrovascular symptoms in this group of 100 patients. Fifty-five experienced a single event with abrupt onset of symptoms while awake or during sleep. In 5 patients the neurological deficits developed in a gradual stepwise progression over a period of 12 hours to several days. Transient neurological manifestations (presumably caused by cerebral ischemia) developed after the cerebral infarction in 4 patients, whereas in 19 others these symptoms culminated in a "stroke." Thirteen patients gave a history, at the time of admission, of having had recurrent transient neurological disturbances which were thought to be due to cerebral ischemia, but the neurological examination was normal. In 4 cases the mode of onset of the cerebral vascular episode could not be determined from either the patient or his family.

The diagnosis of cerebral infarction was based on the usual clinical findings: the absence of blood in the spinal fluid and the absence of increased intracranial pressure or pineal shift. The patients were given the usual hospital treatment consisting of early ambulation, physiotherapy, nursing management, and supportive care. Stellate block, vasodilator therapy, and steroid therapy were not employed. Twenty-six patients, however, had anticoagulant treatment during the period of hospitalization, which averaged 3 weeks. Only 13 of these patients, however, were maintained on anticoagulants after discharge.

The functional capacity of the 100 patients was determined at the time of their discharge from the hospital and at the end of the first and second years thereafter, at which times all patients were sent a questionnaire. This consisted of a request for information regarding: (1) the patient's working ability, i.e., whether working, able to do light chores, just able to care for self, or requiring nursing care; (2) the patient's health since leaving the hospital, i.e., changes in physical and neurological status, including development of new strokes or new symptoms of any kind. In addition, the patients or their families were requested to describe whether the patient's condition had improved, become worse, or remained unchanged.

In most cases the questionnaires were returned with reasonably complete data. Whenever such information was inadequate or the questionnaire was not returned, the patient was called by telephone. When necessary, direct inquiries were made of the patient's physician or family. If any doubt existed as to the change in physical or neurological status, the patient was brought in for re-examination. Approximately 50 per cent of the surviving patients had a follow-up examination by one of the authors on an outpatient visit or on readmission to the hospital. Using these combined methods we have obtained follow-up information on each of our 100 consecutive patients.

TABLE I. MODE OF ONSET OF CEREBRAL ISCHEMIA AND INFARCTION—100 PATIENTS

TYPE OF ONSET	GRAPHIC REPRESENTATION*	PER CENT
Single event		55
Stepwise progression		5
Cerebral infarction followed by ischemic attacks		4
Transient attacks culminating in stroke		19
Cerebral ischemic attacks without neurological deficits		13
Undetermined		4

*This graphic representation is similar to that used by Cohen and Adams in their illustration of the temporal profile of various types of cerebral disorders. (Cohen, M. E., and Adams, R. D.: Vascular Disease of the Brain, Bull. New England Med. Center 9:180, 222, 261, 1947.)

RESULTS

Outcome During the Initial Hospital Admission.—During hospitalization for cerebral infarction, 10 of the 100 patients died. In 9 cases, death was due to the cerebral infarction or its complications; in one, death ensued one-half hour after cerebral arteriography. Of the 90 patients who were discharged from the hospital, 10 were able to return to their former employment within a few weeks, 35 were ambulatory and able to carry out light part-time work, and 28 could care for their personal needs, feed themselves, and get about with the aid of a wheelchair or cane. The remaining 17 patients were bedridden and required nursing care.

TABLE II. CAUSES OF DEATH IN 100 CASES OF CEREBRAL INFARCTION

CAUSE	FIRST YEAR	SECOND YEAR
Initial cerebral infarction	9	3*
Recurrent cerebral infarction	4	5
Myocardial infarction	4	–
Uremia	2	–
Pulmonary embolism	1	–
Dicumarol treatment—cerebral and gastrointestinal hemorrhage	1	–
Miscellaneous (carcinoma, pancreatitis, suicide, arteriography)	4	–
Total	25	8

*These 3 patients died due to a protracted debilitated state during the second year following their admission to the study.

Late Mortality: One and Two Years After Onset of Stroke.—In addition to the 10 patients who died during the initial hospitalization, 15 others succumbed during the first year following discharge from the hospital. In the second year, 8 more died. This resulted in a mortality rate of 33 per cent during the 2 years following admission to the study. Postmortem examinations were done in one-third of these 33 patients, and they revealed cerebral infarction due to atherosclerosis, thus confirming the original clinical diagnosis. Of the 22 deaths not followed by autopsy, 11 occurred in the hospital under our observation. In the remaining 11, adequate clinical information as to the cause of death was available from the patient's family or physician.

The immediate cause of death in the 33 patients is shown in Table II. In addition to the 9 patients who died of cerebral infarction during their initial hospitalization, following discharge 3 others succumbed due to debility caused by the first stroke. Nine others died of recurrent cerebral infarction, 4 in the first year and 5 in the second year after leaving the hospital. Seven individuals died of vascular disease in other organs such as myocardial infarction (4 patients), renal failure secondary to hypertensive vascular disease (2), and pulmonary embolism complicating congestive failure (1). An additional patient succumbed to cerebral and gastrointestinal hemorrhages complicating Dicumarol therapy. In summary, 29 of the 33 deaths in this study were thought to be due to vascular disease or its complications. In the remaining cases, death was caused by carcinoma, acute pancreatitis, cerebral arteriography, and suicide (committed a few months after beginning Dicumarol therapy).

Of the 67 survivors, 36 reported general clinical improvement at the end of the second year, 22 believed there had been no change since leaving the hospital, and 9 patients stated that they had become worse. As to functional capacity, 16 patients were working at the end of the second year and 31 were ambulatory and able to do small chores or part-time work at sedentary occupations. Fifteen were capable only of minimal personal care and 5 were totally invalid.

In the 2 years following discharge from the hospital, 18 (20 per cent) of the 90 patients developed recurrent cerebral infarction. Eight of these patients suffered another stroke in the first year and 10 others during the second year.

TABLE III. INFLUENCE OF HYPERTENSIVE VASCULAR DISEASE ON PROGNOSIS OF CEREBRAL INFARCTION

STATUS	NUMBER OF PATIENTS	CLINICALLY IMPROVED OR SAME	CLINICALLY WORSE	DEAD
Normotensive	50	31	5	14 (28%)
Moderate hypertensive vascular disease	35	20	4	11 (31%)
Severe hypertensive vascular disease	15	7	0	8 (53%)
Total	100	58	9	33

Nine of these died, 5 became invalids and were bedridden, and 4 recovered sufficiently to return to their previous functional capacity.

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INFLUENCE OF VARIOUS FACTORS ON PROGNOSIS

Age.—The mean age of the patients who died was 61.7 years—somewhat older than the mean of 55.1 years for the 67 survivors and 57.3 for the total series.

Hypertension and Coronary Vascular Disease.—As might be expected, the presence of severe hypertension seemed to influence the prognosis of cerebral infarction. Of the 50 patients without hypertension, death occurred in only 14 (28 per cent). Eleven (31 per cent) of the 35 patients with moderate hypertension and 8 (53 per cent) of the 15 patients with severe hypertensive disease expired (Table III).

Patients with abnormal electrocardiographic findings also tended to show higher mortality rates (Table IV). Death occurred in 17 (46 per cent) of the 37 patients with definite electrocardiographic changes and in only 14 (29 per cent) of the 48 with normal or borderline records. Correction of the ECG and hypertension data to account for the nonvascular deaths resulted in no significant differences in rates. The deaths due to nonvascular causes were divided equally among the patients with normal and abnormal electrocardiograms and among

TABLE IV. INFLUENCE OF ELECTROCARDIOGRAPHIC CHANGES ON PROGNOSIS OF CEREBRAL INFARCTION

ECG STATUS	NUMBER OF PATIENTS	CLINICALLY IMPROVED OR SAME	CLINICALLY WORSE	DEAD
Normal ECG	48	30	4	14 (29%)
Abnormal ECG	37	17	3	17 (46%)
Total	85	47	7	31

those with normal blood pressure and hypertensive disease. The patients dying of myocardial disease and coronary thrombosis were among those with definite ECG changes.

Previous Cerebral Infarction.—Patients who had one or more cerebral infarctions *prior* to their admission to the study had a considerably poorer outlook than those having their initial cerebral vascular episode (Table V). Of the 77 patients with a single cerebral infarction admitted to the study, 5 died during the initial hospitalization, 10 during the first year, and 4 in the second year, making a total of 25 per cent. The 23 patients with a history of previous cerebral infarction, however, had a total mortality of 61 per cent, with 5 deaths occurring immediately, 5 during the first year, and 4 more in the second year following hospital discharge. It should be pointed out that the patients with more than one stroke were usually more seriously ill at the time of their initial hospitalization. They had a higher incidence of pseudobulbar palsy and dementia, and the percentage of bedridden patients was double that of the patients with a single cerebral infarction.

Location of the Lesion.—Contrary to the experience of Millikan and coauthors,[11] the present study did not reveal higher mortality rates in patients with thrombosis in the vertebral-basilar system. Of the 48 patients known to have occlusion in the carotid system, 19 (40 per cent) died; whereas 9 (28 per cent) of 32 patients with vertebral-basilar occlusion were dead at the end of 2 years (Table VI). Here again, the patients with nonvascular causes of death were

TABLE V. EFFECT OF PREVIOUS CEREBRAL INFARCTIONS ON PROGNOSIS

NUMBER OF INFARCTIONS	NUMBER OF PATIENTS	CLINICALLY IMPROVED OR SAME	CLINICALLY WORSE	DEAD
Single infarction	77	52	6	19 (25%)
Multiple infarctions (2 or more)	23	6	3	14 (61%)
Total	100	58	9	33

equally distributed among the two groups and did not influence the mortality rates. It should be emphasized that the prognosis of patients with basilar thrombosis depended upon the exact site and extent of the lesion as indicated by the presence of bilateral signs and symptoms. Seven of the 15 patients with bilateral brain stem signs died within 2 years, all of basilar occlusion, as compared with 2 deaths in 17 patients with unilateral signs of a brain stem lesion (only 1 of whom died directly from cerebrovascular disease). In the 20 patients in whom infarction could not be localized, there were 5 deaths (25 per cent).

Influence of Anticoagulant Therapy.—Thirteen patients received anticoagulants during the year following hospitalization. Of these, 2 died, 1 from suicide and the other from gastrointestinal and cerebral hemorrhage. At the end

of the 2 years, 3 of the 11 survivors of this group were working, 6 were able to do light chores, 1 was barely ambulatory, and 1 was an invalid. Although the outcome of these 13 patients was somewhat better than that of those who did not receive anticoagulant therapy, no conclusions can be drawn from this observation. These patients did not have severe hypertension, were generally more cooperative, and were among those with better functional capacity at the time of discharge from the hospital. They also had the advantage of weekly or frequent visits to a physician, which might explain their over-all better results.

Of the 13 patients entering the study with a history of transient neurological symptoms but with a normal neurological examination, 4 died, 3 of cerebral infarction and 1 of uremia. None of these 4 patients received anticoagulant therapy. In the 9 remaining patients, 5 of whom were on long-term anticoagulation, the transient symptoms decreased in frequency or stopped altogether.

TABLE VI. INFLUENCE OF LOCATION OF CEREBRAL INFARCTION ON PROGNOSIS

LOCATION	NUMBER OF PATIENTS	CLINICALLY IMPROVED OR SAME	CLINICALLY WORSE	DEAD
Carotid system	48	25	4	19 (40%)
Vertebral-basilar system	32	19	4	9 (28%)
Indeterminate	20	14	1	5 (25%)
Total	100	58	9	33

DISCUSSION

The outcome of cerebral infarction is usually divided into two major categories: (1) the immediate mortality or morbidity which develops within a few weeks after the onset of infarction; and (2) the late prognosis. The factors known to increase the immediate mortality have been studied extensively and consist of such signs as deep coma, high fever, Cheyne-Stokes respiration, inequality of pupils, and bilateral extensor plantar reflexes. These manifestations usually indicate severe brain damage and would be expected to affect adversely the patient's chances of recovery. Severe cerebral edema associated with the infarction is also a serious prognostic sign. Such patients may show displacement of the pineal gland or cerebral vessels on roentgenographic examination or increased intracranial pressure on lumbar puncture. In a few instances, a very high spinal fluid leukocytosis (500 to 2,000 cells) or an elevated protein content is associated with massive cerebral infarction, but these findings are variable.[13] In our experience, electroencephalographic changes have not been a useful prognostic sign and do not correlate well with the severity or size of the acute infarct.[14]

The initial mortality of 10 per cent observed in this study is similar to that observed by Pincock[6] and by Tennent and Harman,[1] who found that 9.5 and 7.5 per cent of their patients, respectively, succumbed shortly after their cerebral

infarction. In other studies, however, the immediate mortality has been considerably higher, ranging from 15 to 58 per cent. This wide variation is probably due to the type of patient selected for hospital admission or to the various criteria established for diagnosis. Earlier studies, for example, did not usually include patients with cerebral ischemic attacks, which are now generally considered to be associated with a significant degree of occlusive cerebrovascular disease.

In the present study, emphasis was placed on the factors influencing the long-term outcome of cerebral infarction. It was found that the majority of late deaths were caused by cerebrovascular disease, but a significant number were due to vascular involvement in other areas. The extent of cerebral arteriosclerosis was of considerable prognostic significance, as shown by the much higher mortality rate in the patients with more than one cerebral infarction prior to admission to the study and by the fact that 9 of the 23 late deaths in the study were due to recurrent cerebral infarction. It is difficult to reconcile these results with those of Pincock,[6] who found that the mortality due to recurrent cerebrovascular disease in his study was probably the same as could be expected in the general population. The degree of generalized vascular disease also influenced the late prognosis as suggested by the higher mortality in patients with severe hypertension and coronary artery disease. These factors assumed importance in long-term prognosis, but had a lesser role in the immediate outcome.

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The serious influence of cerebral infarction on mortality is indicated by the death rate in one year of 15 (16.6 per cent) of the 90 patients discharged from the hospital. This finding is comparable to that of Robinson and his group[8] who found a mortality rate in one year of 15 per cent of those surviving the initial stroke. This is more than ten times the annual rate of 1.4 per cent reported for the population at large for ages 55 to 59.[15] Our 2-year mortality rate of 25 per cent of the 90 immediate survivors was remarkably similar to that of Lindgren,[7] who reported 15 deaths (26 per cent) in 58 patients during the same interval. Although the mean age of his subjects was somewhat lower, the presence of arteriographically demonstrable vascular occlusions in his group indicated a relatively large area of cerebral infarction. In addition, a number of his patients had overt cardiovascular disease as the source of a cerebral embolus.

Many of our patients had coronary artery disease and a few died of myocardial infarction. It is of interest to compare the age of onset and prognosis of myocardial infarction with those of cerebral infarction. In one study,[16] the mean age of onset of myocardial infarction was 56.7 years, with 22 per cent of the patients being less than 50 years of age—findings quite similar to those observed in this study. Although the immediate mortality of myocardial infarction is usually greater than that of cerebral infarction, the death rate during the first year was comparable, with 12.7 per cent of patients with myocardial infarction succumbing during this period.[17] In both cerebrovascular disease and cardiovascular disease, the death rates are higher in the older age group. In our study, 22 of the 23 patients dying during the 2 years following hospital discharge were over 50 years of age.

There were moderate differences in the working capacity of the survivors reported in the various studies of cerebral infarction. Only 16 (24 per cent) of

our 67 survivors and 19 per cent of those studied by Rankin[3] were able to return to work, whereas 39 per cent of the patients studied by Lindgren[7] were able to carry out either full-time or half-time employment. More than one-half of his group were also able to take care of themselves, compared to 46 per cent in our study and 45 per cent in Rankin's report. The fact that Lindgren's patients were considerably younger than ours may account for these differences. There is no doubt, however, that the working capacity of the patient depends upon a number of factors other than the severity of the infarction. The part of the brain involved, the socioeconomic status, and the degree of motivation supplied by the patient and his family will determine to a large extent his ability to return to work.

The effect of anticoagulants cannot be determined from this study. There were, however, only 2 deaths among the patients treated with this medication. Conclusions as to the efficacy of Dicumarol treatment will depend upon adequate, large-scale, controlled studies such as those now being carried on by the Veterans Administration and Public Health Service. The fact that the majority of late deaths were caused by recurrent cerebral infarction or by vascular occlusions in other organs would suggest that anticoagulant therapy may be useful in reducing the late mortality rate.

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SUMMARY

A prospective study was made of the survival of 100 patients with cerebral infarction or ischemia due to atherosclerosis. During the initial hospitalization, 10 patients died as a result of the acute infarction or its complications. In the ensuing 2 years, 23 additional patients died—usually from cerebral or systemic vascular disease. Increased mortality was found in patients having a history of previous cerebral infarction, signs of diffuse or bilateral brain stem lesions, or severe hypertension. Approximately one-fourth of the survivors returned to work.

The serious prognosis of cerebral infarction is demonstrated by this study, and attention is directed to the high rate of recurrence (20 per cent) of cerebral infarction among the immediate survivors. Although treatment of the generalized atherosclerosis and its thromboembolic complications may be successful in decreasing the over-all mortality, a more definitive therapeutic approach to the cerebral vasculature by surgery or other means appears necessary to reduce the high mortality and morbidity caused by recurrent strokes.

We are indebted to Dr. George Porter, Mrs. Mary Pike, and Mrs. Molly Terry for their assistance in this study.

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PREVALENCE AND INCIDENCE OF CORONARY HEART DISEASE IN STRATA OF THE LABOR FORCE OF A CHICAGO INDUSTRIAL CORPORATION

J. STAMLER, M.D.,*
H. A. LINDBERG, M.D.,
D. M. BERKSON, M.D.,
A. SHAFFER, M.D.,
W. MILLER, B.S., AND
A. POINDEXTER, M.D.

WITH THE TECHNICAL
ASSISTANCE OF
M. COLWELL AND Y. HALL

CHICAGO, ILL.

From the Heart Disease Control Program, Chicago Board of Health; the Department of Medicine, Northwestern University Medical School; and the Cardiovascular Department, Medical Research Institute, Michael Reese Hospital

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LATE in 1954, a long-term research program was instituted by our group on the epidemiology of the cardiovascular-renal diseases. The principal objective of this work has been to explore problems of the occurrence, natural history, and etiology of both hypertensive and atherosclerotic cardiovascular diseases. The initial phase of this research involved an analysis of mortality rates for these diseases in different strata of the middle-aged population of Chicago, the State of Illinois, and the United States.[1-6]

In 1957 this program was extended to include studies in the living population. The present report is concerned with one phase of this latter continuing investigation. It presents epidemiologic findings on the cardiovascular-renal diseases, particularly coronary heart disease, in the middle-aged male members of the labor force of a Chicago utility corporation.†

This work was made possible by virtue of support from the Chicago Heart Association and the National Heart Institute, U. S. Public Health Service (H2984 and H4197).

*This work was initiated during the senior author's tenure as an Established Investigator of the American Heart Association in the Cardiovascular Department, Medical Research Institute, Michael Reese Hospital (Louis N. Katz, M.D., Director).

†Detailed data on hypertension and hypertensive heart disease were presented before the Annual Meeting of the Council for High Blood Pressure Research of the American Heart Association, Cleveland, Ohio, Nov. 21, 1958, and were published in the Proceedings of that meeting.[7]

METHODS

The data of the present report were obtained through analysis of accumulated medical and personnel records of a Chicago utility corporation. They deal with 784 men aged 50 to 59 on Jan. 1, 1954—the entire labor force in this age-sex group.

The medical department of this company has for many years been carrying out annual medical examinations of its middle-aged employees. This voluntary program is utilized by virtually all eligible employees, i.e., employees 40 years of age or older. Thus, of 784 men aged 50 to 59 on Jan. 1, 1954, base-line medical data were available on 756 and follow-up data for the period 1954 to 1957 were available on 740 (Table I). The annual examination has consisted of an interim

TABLE I. STATUS OF 4-YEAR FOLLOW-UP INFORMATION ON TOTAL STUDY POPULATION

Number examined and on whom data were available as of Jan. 1, 1954—participants in study		756	
Number not examined and on whom no data were available as of Jan. 1, 1954—nonparticipants in study		28	
Total			784
Follow-up of participants in study			
Status as of Dec. 31, 1957, known:			
Deceased	41		
Close-out data available, working	670		
Close-out data available, retired, cardiovascular-renal disease	15		
Close-out data available, retired, non-cardiovascular-renal disease	7		
Close-out data available, on extended sick benefits, cardiovascular-renal disease	4		
Close-out data available, on extended sick benefits, non-cardiovascular-renal disease	3		
Total, status known as of Dec. 31, 1957		740	
Status as of Dec. 31, 1957, uncertain:			
No close-out data, working	6		
No close-out data, retired	4		
No close-out data, left company	6		
Total, status uncertain as of Dec. 31, 1957		16	
Total			756

medical history, physical examination, urinalysis, 9-lead electrocardiogram (leads I, II, III, aV_R, aV_L, aV_F, V_2, V_4, V_6), and 14 by 17 inch posteroanterior chest film. The accumulated reports of these annual examinations were utilized for the purposes of this study. During 1954, 627 of the study group were examined; during 1955, 599; 1956, 652; 1957, 670; 433 were examined annually during the 4 years; 604 were examined in 3 of the 4 years.

Of the 756 men aged 50 to 59 on Jan. 1, 1954, on whom base-line medical data were available (737 white, 19 nonwhite), 601 (79 per cent) had been in this company's employ for 20 years or longer, 312 (41 per cent) for 30 years or

longer. Virtually all employees had had pre-employment physical examinations, as well as visits at intervals to the medical department during the years prior to institution of the periodic examination program. Therefore, extensive data were available on many of these men, particularly weight and blood pressure data accumulated since the onset of their employment, i.e., since their teens or young adulthood.* In addition, extensive sociologic data on these individuals were available in their personnel records. These too were subjected to systematic analysis for the purposes of this study.

The following procedure was utilized to abstract the medical data: First, all charts were reviewed and findings coded by nurses and medical students working during the spring, summer, and fall of 1957. Their instructions were to record any and all positive or suspected cardiovascular-renal findings, whether or not a positive diagnosis was recorded. All charts with positive findings were then subjected to review by an internist (David M. Berkson, M.D.). In addition, a 15 per cent random sample of the apparently negative charts was similarly reviewed. Further, all the accumulated electrocardiograms on the 756 men were reviewed by an electrocardiographer (Aaron Shaffer, M.D.). In addition, all subjects with positive diagnoses remaining alive and available in 1958 were recalled for re-examination by a physician (Albert Poindexter, M.D.). Private physicians and hospitals were also consulted and their reports reviewed in order to validate diagnoses. All death certificates were obtained on the decedents. Definitive diagnostic decisions on problem cases were made by the research group through joint review of the data. Diagnostic criteria were based on the New York Heart Association Criteria, as modified in recent studies.[8-11]

In the diagnosis of definite coronary heart disease, the following clinical forms of this disease were distinguished: myocardial infarction, based on a clearly documented history plus confirmatory serial ECG findings (QRS changes); asymptomatic myocardial infarction, based on *de novo* development from one year to the next of characteristic ECG changes (Q waves of diagnostic amplitude and duration); sudden death (see Table III); angina pectoris, based on a history of characteristic pain or distress; acute coronary insufficiency, based on attacks of prolonged coronary pain in which no definitive evidence of myocardial infarction appears; and congestive heart failure of probable coronary causation, based on clearly documented findings of congestive heart failure, in the absence of evidence of other forms of heart disease. For each of these forms of coronary heart disease except sudden death, a suspect diagnosis could be made when the findings were atypical or equivocal. Suspected coronary heart disease was the diagnosis made in cases with a history of myocardial infarction, without available confirmatory ECG data. Suspected coronary heart disease was also the designated diagnosis in cases with no other apparent type of heart disease, which exhibited the following ECG patterns—left bundle branch system block, right bundle branch system block, auricular fibrillation or other significant arrhythmia, nonspecific ST-T changes.

*Analysis of these data has been presented elsewhere[7] (see previous footnote).

Body weight was evaluated by comparison with adjusted median weight for height of the Framingham study, the ratio $\frac{\text{actual weight}}{\text{median weight for height}} \times 100$ being designated relative weight.[10] Comparison of Framingham median weight with accepted values for desirable weight at any given height reveals the former to be in excess of the latter by 11 to 19 pounds (Table II). This is not unexpected, in view of the prevalence and degree of obesity among contemporary middle-aged American men. The relative weight range 100 to 112 was therefore designated as moderate obesity, the range 113 and greater as marked obesity.

TABLE II. RELATIONSHIP BETWEEN FRAMINGHAM MEDIAN WEIGHT AND DESIRABLE WEIGHT FOR MEN

HEIGHT (INCHES)	FRAMINGHAM MEDIAN WEIGHT* (POUNDS)	DESIRABLE WEIGHT† (POUNDS)
60	136	125 ± 13
62	144	130 ± 13
64	152	135 ± 14
66	160	142 ± 14
68	168	150 ± 15
70	176	158 ± 16
72	184	167 ± 17
74	192	178 ± 18

*Calculated from the formula: median weight = 136 + 4 (height − 60). (See reference 10.)
†Desirable weights from "Recommended Dietary Allowances," Revised, 1958. A Report of the Food and Nutrition Board. National Academy of Sciences—National Research Council Publication 589, Washington, D.C., 1958.

RESULTS

Of the base population of 756 men, 19.4 per cent had hypertension, i.e., a diastolic blood pressure 95 mm. Hg or above on or about Jan. 1, 1954*; 14.6 per cent had borderline diastolic hypertension (90 to 94 mm. Hg); 21.6 per cent were frankly obese (relative weights of 113 and over) (Fig. 1).

The data on prevalence of individual cardiovascular-renal diseases and diabetes mellitus at the onset of the study are summarized for the entire group in Fig. 2. The data for such entities as coronary heart disease, rheumatic heart disease, and diabetes mellitus—prevalence of approximately 7 per cent, 2 to 3 per cent, and 2 per cent, respectively—are in good agreement with results obtained by others for middle-aged, working, white, urban Americans.

Incidence rates—i.e., rates of development of new clinical disease in the population free of definitive signs of that disease at the beginning of the study—are summarized for the 4-year period in Fig. 3. The data on incidence of coronary heart disease were stratified to analyze the influence of several medical and sociologic variables. Data on the effects of blood pressure and weight are presented

*Data on blood pressure in this population are presented in greater detail elsewhere (see previous footnotes and reference 7).

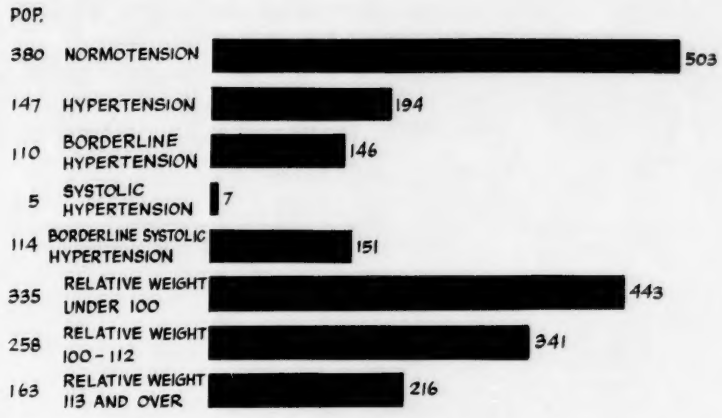

POP.
380 NORMOTENSION 503
147 HYPERTENSION 194
110 BORDERLINE HYPERTENSION 146
5 SYSTOLIC HYPERTENSION 7
114 BORDERLINE SYSTOLIC HYPERTENSION 151
335 RELATIVE WEIGHT UNDER 100 443
258 RELATIVE WEIGHT 100 - 112 341
163 RELATIVE WEIGHT 113 AND OVER 216

Fig. 1.—Prevalence of hypertension and obesity among men aged 50 to 59 years on Jan. 1, 1954. All prevalence rates (given to the right of the bar) are per 1,000 population. Hypertension is defined as a diastolic pressure of 95 or greater mm. Hg. Borderline hypertension is a diastolic pressure in the range 90 to 94 mm. Hg. Systolic hypertension is a systolic pressure of 160 or greater mm. Hg with a diastolic pressure less than 90. Borderline systolic hypertension is a systolic pressure of 140 to 159 mm. Hg with a diastolic pressure less than 90.[9] Relative weight is an index relating weight to height. It is calculated according to the formula used in the Framingham study.[9,10] This index is the ratio (× 100) of an individual's observed weight to the median weight for his sex-age-height group.

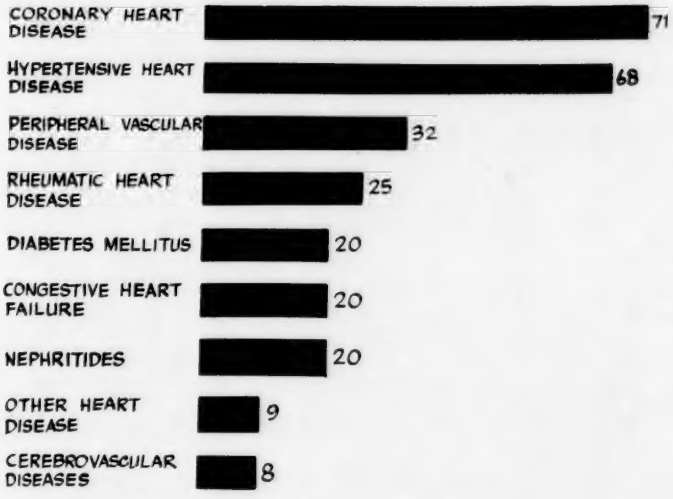


Fig. 2.—Prevalence of individual cardiovascular-renal diseases among 756 men aged 50 to 59 years on Jan. 1, 1954. All rates are per 1,000 population.

in Fig. 4. It is to be noted that obesity was associated with a doubling of the risk of developing coronary disease, and hypertension with almost a tripling of the risk. Of interest is the fact that diastolic blood pressure in the range 90 to 94

(borderline hypertension, according to the definition of this study) was associated with an increase in risk equal to that of blood pressure elevation in the range 95 and greater. The lowest incidence rate for coronary heart disease was in the nonobese, normotensive group (28/1,000 during 4 years); the highest rate was in the obese hypertensive group (101/1,000 during 4 years)—a three and one-half fold increase in risk.

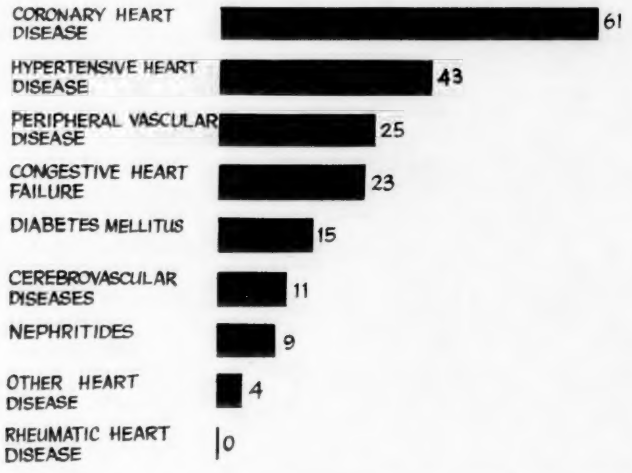


Fig. 3.—Incidence of individual cardiovascular-renal diseases, among men aged 50 to 59 years, between Jan. 1, 1954, and Dec. 31, 1957. All rates are per 1,000 population for 4 years. The base population was free of definite evidence of the given disease at the onset of the study.

In Fig. 4, coronary heart disease included cases of myocardial infarction, sudden death, angina pectoris, acute coronary insufficiency, and congestive heart failure of probable coronary causation. Analysis of the association between obesity-hypertension and myocardial infarction–sudden death was consistent with the findings for all forms of coronary disease. Thus, the incidence rates for myocardial infarction and sudden death for 4 years were: all—28/1,000; nonobese—19/1,000, obese—35/1,000; normotensive—11/1,000, borderline hypertensive—57/1,000, hypertensive—43/1,000. Hypertension, therefore, was associated with a marked increase in risk of developing *de novo* myocardial infarction–sudden death. These data are consistent with recent observations of others.[1,2,10,13,18]

The associations between diabetes and obesity, diabetes and hypertension, and diabetes and coronary heart disease were also studied. In the small group of diabetics available for analysis, prevalence rates for obesity and hypertension were similar to those of the nondiabetics. Coronary heart disease occurrence rates (prevalence plus incidence) were twice as great in the diabetics as in the nondiabetics. These findings are in accord with previous observations that diabetes is associated with an increased risk of coronary heart disease.[15] However, the

numbers here are small, and further work is necessary to delineate this association more definitively in this population.

At the beginning of the study, 36 individuals were found to have suspected coronary heart disease—i.e., suspected angina pectoris, suspected but not verified myocardial infarction, nonspecific electrocardiographic changes of suspected coronary causation (e.g., left bundle branch system block, ST-T changes), etc. The incidence rate of coronary heart disease was almost twice as high in this suspect group as in the group which was free of disease on Jan. 1, 1954 (111/1,000 during 4 years versus 60/1,000 during 4 years). However, the numbers in the suspect group are small here, too. Again, further work is necessary to delineate the prognostic significance, particularly of such electrocardiographic indices of suspicion as right bundle branch block, left bundle branch block, and nonspecific ST-T changes. Such further follow-up data are presently being collected on a larger group of about 2,000 persons aged 40 to 59 participating in the periodic medical program of this company.

Of 54 individuals with definite coronary heart disease on Jan. 1, 1954, 7 died during the 4 years of the study—a death rate of 130/1,000 for 4 years, compared with rates of 17/1,000 and 28/1,000 for 4 years in the normal and suspect groups.

For the entire study population of 756 men, the number of coronary heart disease deaths totaled 19. Eight of these were sudden deaths, 5 occurring in individuals as the initial manifestation of the disease (i.e., in people previously

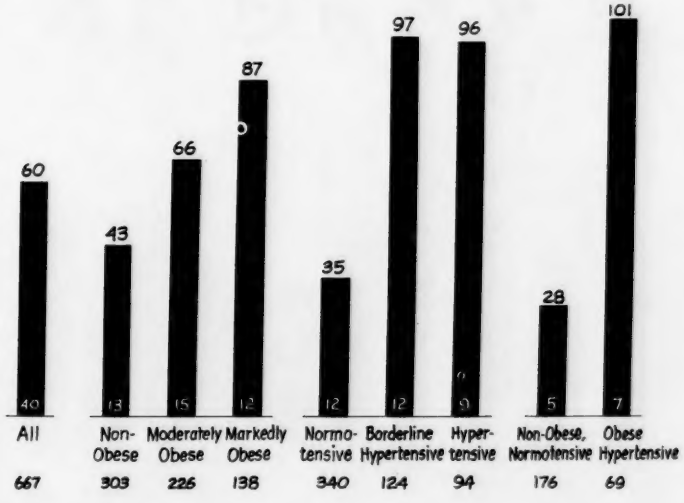


Fig. 4.—Hypertension, obesity, and incidence of coronary heart disease, males aged 50 to 59 years, Jan. 1, 1954, to Dec. 31, 1957. The data cover persons free of coronary heart disease (definite or suspected) at the onset of the study period. All incidence rates (figures above bars) in this and subsequent figures represent the number of persons developing new disease per 1,000 population over the 4-year period Jan. 1, 1954, through Dec. 31, 1957. The base population (denominator) for this incidence calculation (given at the bottom of the figure) represents the number of persons in this group originally free of the cited disease on or about Jan. 1, 1954. The actual number of persons developing new disease (the numerator of the rate calculation) is given inside the bar, at its bottom.

Fig. 5.

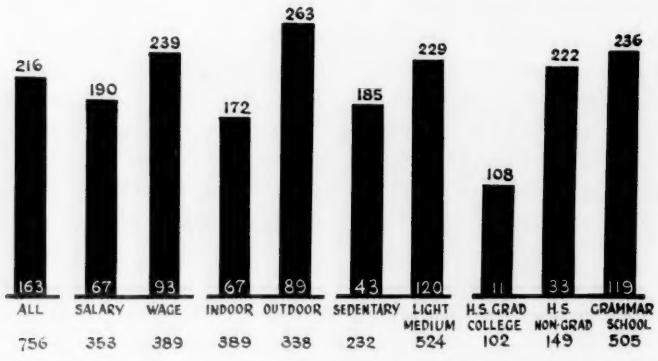


Fig. 6.

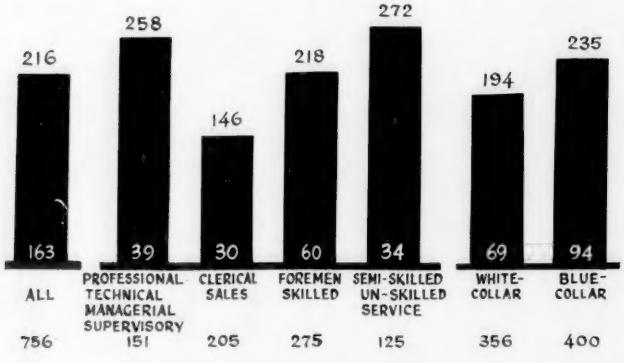
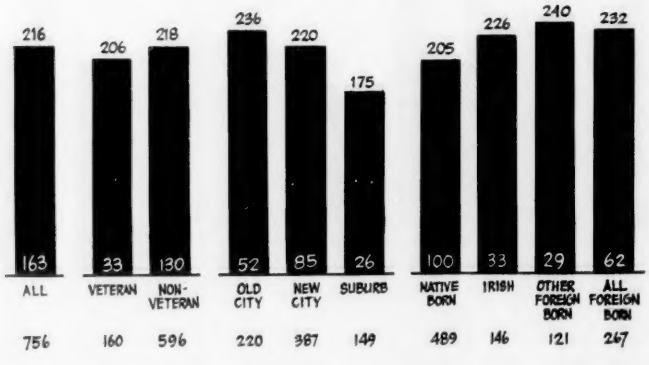


Fig. 7.



Figs. 5 to 7.—Sociologic variables and prevalence of obesity (relative weight 113 and over), 756 males aged 50 to 59 years on Jan. 1, 1954.

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diagnosed as free of clinical coronary heart disease). The total mortality in this population during the 4 years of the study is summarized in Table III.

Of the 40 incident cases of coronary heart disease in the 665 persons free of disease on Jan. 1, 1954, 11 (28 per cent) were fatal cases. These findings are in close agreement with those of other prospective epidemiologic studies.[1,2,10,13]

Data on blood pressure and incidence of cerebrovascular diseases revealed that definite hypertension was associated with a two and one-half fold increase in risk, in accordance with well-known experience in middle-aged males. Here again the numbers are small (only 7 stroke cases total), and further studies in the larger population currently under observation are essential, especially in conjunction with an effort to distinguish among cerebral thrombosis, cerebral hemorrhage, and cerebral embolism.[1,19]

TABLE III. SUMMARY OF DEATHS*

CAUSE OF DEATH	NUMBER
Coronary occlusion, acute myocardial infarction	15†
Arteriosclerotic heart disease	2
Chronic myocarditis	2‡
Hypertensive heart disease	1
Rheumatic heart disease	2
Aorta aneurysm	1
Cerebral hemorrhage	2
Diabetes	1
Malignancies	12
Bronchopneumonia	1
Accident	2
Total	41

*Death certificates were obtained on 39 of the 41 cases.

†Of these 15, 8 were described as sudden deaths, 3 were designated as dying in 5 to 60 minutes, 3 within 24 hours of onset of illness, 1 of unknown duration.

‡Both these cases were signed out with this diagnosis by coroner's physicians without autopsy; their previous medical diagnoses were coronary heart disease (see reference 4).

In addition to analysis of the data based on the foregoing medical variables, stratification was accomplished based on several sociologic variables analyzed from the personnel records. Data on the prevalence of obesity in the several sociologic subgroups reveal a high prevalence in virtually all (Figs. 5 to 7). Noteworthy is the fact that the more educated, indoor, sedentary, white-collar employees tend to have lower prevalence rates for obesity. However, these differences are not statistically significant. No differences were observed between the native-born and the foreign-born (see below) (Fig. 7).

Similar analysis of the data on prevalence of definite and borderline hypertension in the several sociologic subgroups also revealed essentially no differences (Figs. 8 to 10). Again, no differences were observed between the native-born and the foreign-born (see below) (Fig. 10).

Fig. 8.

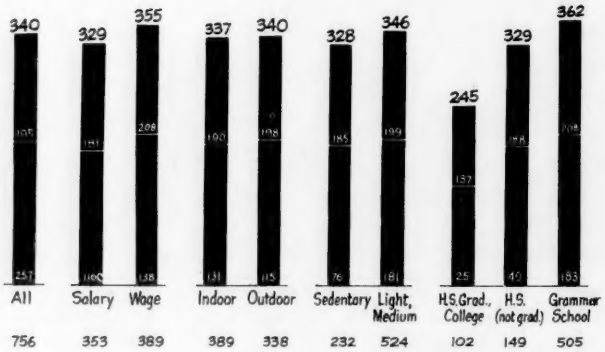


Fig. 9.

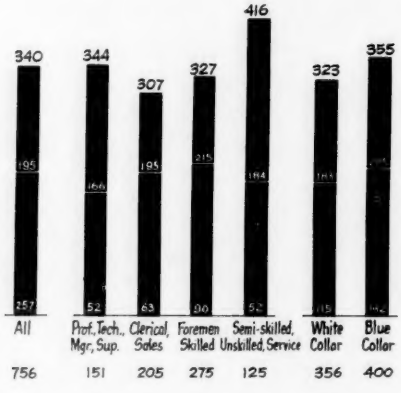
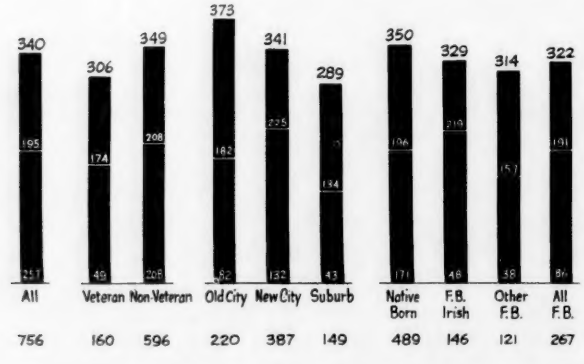


Fig. 10.



Figs. 8 to 10.—Sociologic variables and prevalence of hypertension, 756 males aged 50 to 59 on Jan. 1, 1954. Hypertension includes borderline (90 to 94 mm. Hg) and definite (95 and greater mm. Hg) diastolic blood pressure. The number above each bar (340 for all employees) is the prevalence rate (per 1,000 population) of elevated blood pressure, using a diastolic level of 90 or greater mm. Hg as the criterion for hypertension. The number in the middle of each bar (195 for all employees) is the prevalence rate (per 1,000) of elevated blood pressure, using a diastolic level of 95 or greater mm. Hg as the criterion for hypertension.

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The incidence rates of new coronary heart disease in the subgroups stratified by sociologic variables are presented in Figs. 11 to 13. For most subgroups, uniformly similar rates were noted. The lower rate in the semiskilled-unskilled service workers, compared with other occupational subgroups, is not at the level of statistical significance (Fig. 12). The marked differences in rates between the native-born and foreign-born, particularly the foreign-born Irish (the only sizable specific nationality group among the foreign-born), are statistically significant.*

These differences between native-born and foreign-born hold for the limited group of cases of myocardial infarction and sudden death within the coronary heart disease incidence group as a whole. Thus, the incidence rates for myocardial infarction–sudden death in the native-born and foreign-born were 38/1,000 and 16/1,000 for 4 years, respectively.

While these differences between native-born and foreign-born Americans are significant and noteworthy, it is essential to make the further observation that the rates in the foreign-born are by no means low, in an absolute sense. Thus, the foreign-born rate of 34/1,000 during 4 years represents a risk of about one in six of developing clinical coronary disease during the 20 years of middle age from 45 to 64. This is a substantial risk, particularly compared with that for men of the same age in many other countries.[1,2,13]

Since the prevalence rates of obesity and hypertension were similar in the native-born and foreign-born, the lower coronary heart disease incidence rates in the foreign-born apparently cannot be attributed to hypertension and obesity as variables. However, the incidence of the combination, hypertension plus obesity, was somewhat lower in the foreign-born than in the native-born (83/1,000 versus 138/1,000).

The bulk of the foreign-born (145 of 267) were skilled workers or foremen. It was therefore possible to compare coronary heart disease incidence rates in native-born skilled workers and foremen (130 men) versus foreign-born skilled workers and foremen. The coronary heart disease incidence rates were 93/1,000 in the former versus 30/1,000 for 4 years in the latter. Hence the difference in coronary heart disease incidence rates between the native-born and foreign-born does not appear to be related to their respective occupational backgrounds.

DISCUSSION AND CONCLUSIONS

As the present study demonstrates, accumulated data in the medical and personnel departments of industries, especially those accomplishing periodic medical examinations of sizable strata of their labor force, constitute a rich potential source of data for epidemiologic analyses of cardiovascular-renal diseases. Given the prerequisite cooperation of crucial groups—university hospitals, research institutes, public health agencies, professional colleagues, heart associations, management and labor, medical and personnel departments—it is quite

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*The statistical analyses were accomplished by David Wallace, Ph.D., Department of Statistics, University of Chicago, serving as statistical consultant. It is a pleasure to acknowledge his important contribution.

Fig. 11.

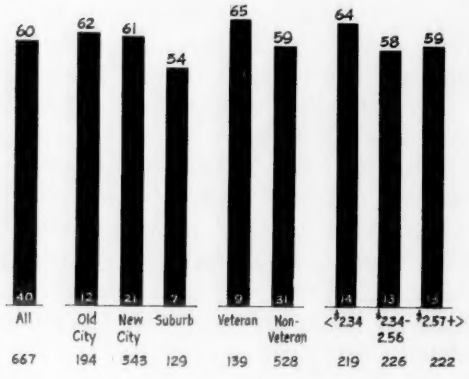


Fig. 12.

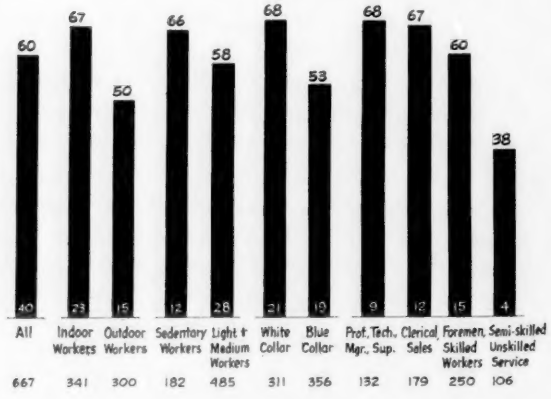
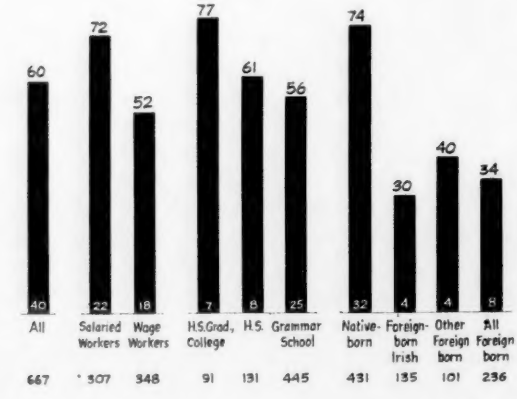


Fig. 13.



Figs. 11 to 13.—Sociologic variables and incidence of coronary heart disease, males aged 50 to 59, Jan. 1, 1954, to Dec. 31, 1957. Data cover persons free of coronary heart disease (definite or suspected) at the onset of the study period.

possible to carry out extensive epidemiologic studies in industry. These studies can take the form of analyses of accumulated records or prospective studies on strata of the labor force. Investigations based on industrial records have at least three important advantages. First, they deal with people in relation to their work. Obviously, what persons do for a living basically influences their mode of life—and it is a cardinal premise of epidemiology that aspects of the mode of life may be of decisive importance in etiology of the chronic diseases. Second, epidemiologic research utilizing established industrial medical departments is considerably less expensive than epidemiologic research "starting from scratch" in a community. It is reduced in cost to an endeavor budgeted in five, instead of six, figures. Third, in those industrial medical departments with long-established programs, it is possible to utilize the accumulated data to obtain, rapidly and inexpensively, reliable epidemiologic information covering years of elapsed experience. It is our firm conviction that more studies of this kind would be highly desirable.

The data of the present study demonstrate that the prevalence rates of hypertension and obesity are high in all subgroups (based on sociologic stratification) of this population of urban, employed, white, middle-aged, American males. Other data indicate that serum cholesterol levels also tend to be high, the mean value being 239 mg. per cent, with 20 per cent of the men having levels of 275 mg. per cent or greater, 9 per cent 300 mg. per cent or greater.[27] High prevalence rates for hypertension, obesity, and hypercholesterolemia have been shown to be associated with high incidence rates for clinical coronary heart disease. Therefore, the finding that virtually all subgroups—with the limited but definite exception of the foreign-born—have uniformly high incidence rates of clinical coronary heart disease is the predicted, anticipated finding. It is a finding consistent with the results of mortality analyses and other recent studies of the living population in the United States.[1,2,4-6,10,13,18,20-26]

Based on these observations, it would seem valid to infer that these American subgroups must have certain factors in common overriding the differences among them—factors which cut across their heterogeneity, which is based largely on their diverse modes of earning a living. These common features would appear to be etiologically significant for the genesis of coronary heart disease with epidemic frequency in middle age. Several possibilities immediately come to mind—e.g., patterns of diet; physical activity, energy expenditure, large muscle activity, physical fitness; tension, stress, fatigue, pace and complexity of living; familial hereditary factors (metabolic, hormonal, et al.). It is not unreasonable to postulate that these factors, of possible etiological significance in the genesis of atherosclerotic coronary heart disease, are manifest to a similar frequency and degree in the several sociologic subgroups.[1,2,13] Research is confronted with the challenge of delineating these common etiological factors and the interrelationships among them—a challenge which has been taken up vigorously.

Finally, the data of the present study demonstrate again that it is now highly feasible to assess risk of coronary heart disease in healthy persons and to identify susceptibles. Of course, direct prediction is not possible, i.e., the definite

determination of whether or not an individual will develop coronary disease in the ensuing 2 or 5 or 20 years. The fact is that medical science lacks predictive ability of this degree of accuracy for most diseases. But it is quite possible to make at least semiquantitative actuarial assessments of relative risk—e.g., to state that the chance that a given person will develop clinical coronary disease between the ages of 40 and 59 or 45 and 64 is one in twenty, one in ten, one in five, or one in two. The foregoing range of risks is not arbitrarily selected, since the extensive findings of recent prospective epidemiologic studies indicate that these are in fact the risks for different groups of healthy, middle-aged males.

It should be further emphasized that the several criteria for assessing risk—particularly blood pressure, weight, serum cholesterol, family history of premature occurrence of cardiovascular-renal disease, plus such factors as history of hypothyroidism, diabetes, renal damage, heavy smoking, and others that may be significant (e.g., degree of large muscle activity, stress, tension, fatigue, overwork)—are all simple, familiar, routine determinations in any adequate medical work-up. By utilizing these data to assess risk of coronary disease, the physician acquires a new dimension in approaching the individual patient.

As the recent report to the American Heart Association and the American Society for the Study of Arteriosclerosis noted, persons who manifest multiple abnormalities and are therefore susceptible deserve the aid of modern medical practice in the elimination or minimization of these defects, in an attempt to reduce risk before they develop clinical disease.[14] These individuals can be counted in the millions in the United States today, since 10 to 15 per cent of middle-aged males exhibit two or more of the cardinal abnormalities (see Fig. 4 and reference 10).

SUMMARY

1. An epidemiologic analysis of coronary heart disease and other cardiovascular-renal diseases was accomplished, utilizing the accumulated medical and personnel records on the entire male labor force aged 50 to 59 years (784 men) of a Chicago utility company.

2. Observed prevalence and incidence rates for coronary heart disease were 71/1,000 and 61/1,000 for 4 years, respectively.

3. The over-all mortality rate from coronary heart disease was 25/1,000 for 4 years. The mortality rate in those free of coronary heart disease at the onset of the study was 17/1,000 for 4 years. Of all deaths, 47 per cent occurred suddenly.

4. Hypertension, obesity, diabetes mellitus, and suspected coronary heart disease were associated with increased incidence rates of definite coronary heart disease.

5. Prevalence rates of hypertension and obesity were similar in sociologic subgroups of the total population under study. Sociologic stratifications were made based on nativity, residence, military experience, education, occupation, physical activity of work, indoor versus outdoor work, and type and amount of income.

6. Coronary heart disease incidence rates were similar in the sociologic subgroups, with the exception that significantly lower rates were observed in the foreign-born than in the native-born. Coronary heart disease incidence rates are high in all strata of the middle-aged male population in the United States.

It is a pleasure to acknowledge the encouragement and support forthcoming from Herman N. Bundesen, M.D., President, Chicago Board of Health, and the staff of the Chicago Board of Health, particularly Messrs. Frank Bauer, Marvin Templeton, and Carl Kolometz. It is also a pleasure to acknowledge the excellent cooperation forthcoming from the officers, executive board, and staff of the cooperating utility company and its several departments. The vital advisory contribution of the Planning Committee for Epidemiologic Investigation of Cardiovascular Disease in the Chicago Living Population and that of the official Advisory Committee to the Heart Disease Control Program, Chicago Board of Health (Gene Stollerman, M.D., Committee Chairman), are also gratefully acknowledged.

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MORTALITY FROM CORONARY HEART DISEASE AND PHYSICAL ACTIVITY OF WORK IN CALIFORNIA

LESTER BRESLOW, M.D.,* AND PHILIP BUELL**

BERKELEY, CALIF.

From the California State Department of Public Health, Bureau of Chronic Diseases

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SEVERAL British reports have consistently shown an excess of mortality from coronary heart disease with higher social class of occupation[1] and also with decreasing physical activity of work[2,3] among men in England and Wales. Just as consistently, several studies in different cities of the United States have failed to confirm these findings.[4-6] Some evidence bearing on this discrepancy is presented here. The data come from routine California mortality records analyzed according to the occupational entries.

The specific occupations are classified according to social class, physical activity, and a type of job stress. This report attempts to evaluate the mortality, especially from coronary heart disease, by social class and physical activity. A later report[17] will deal with job stress.

METHODS AND DATA

The Census Bureau's index of occupations[7] was used to code the death certificates of men, aged 20 to 64, who had been residents of California during 1949 to 1951.† The deaths were then related to the number of men in each occupation as determined in the Census of 1950. The Census Bureau publishes the numbers of employed men by age and current occupation[8] and provided unpublished sample data for estimates of the unemployed, and those out of the labor force for other reasons, according to their last occupation and age.

In a formal sense, the statement of occupation on the death certificate is not strictly comparable with the occupation stated in the Census. The death

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*Chief, Bureau of Chronic Diseases.

**Associate Public Health Analyst.

†Certificates for 1949 and 1951 were coded in California. The National Office of Vital Statistics did the occupational coding and furnished the California punch cards for 1950. Every effort was made to achieve uniformity of procedure.

certificate requests "usual," defined as "longest-held," occupation, whereas the Census asks for "last" occupation.* Nevertheless, there is evidence, from a study by Buechley and associates[9] in California, of a strong tendency to report last occupation rather than longest-held occupation on the death certificate—thus making the latter in effect somewhat comparable with the Census in respect to statement of occupation. This was determined by comparing occupational histories taken from a sample of lung cancer patients with the subsequent routine death records of these same patients. We have used the data of the Buechley study to estimate the extent to which the mortality ratios of the occupational groups might have been influenced by failure to report last occupation. These estimates, referred to in the text as occupation-reporting bias estimates, are shown and discussed in Appendix A. We could not, of course, estimate the lack of comparability that might arise from Census underenumeration or overenumeration in an occupation.

While the results depend in the first place on sufficient agreement in defining last occupation, it is apparent that a man's last occupation may not always represent his occupational history—particularly in the United States. Some changes in jobs probably take place because of disease and other factors. To some extent this problem is minimized by the broad groupings of occupations in the analysis. The number of job changes that are potentially biasing because they are also occupational-group changes may be few. But if the changes are into a limited selection of jobs, the bias effect may be substantial. In fact, Guralnick and Fales[10] showed that, in the Eastern Health District of Baltimore in 1948, the laborer occupation had the highest proportion of men working in some other occupation 8 years earlier.

Mortality rates for semiskilled and unskilled working classes would be artificially inflated if job changes after onset of disease forced men to accept jobs in these classes shortly before death. The results reported later show that such job changes, if they occur, might accentuate a social class trend in general mortality and possibly minimize an opposite social class trend in coronary heart disease mortality. However, Morris and colleagues[2] showed that higher coronary disease rates for occupations of less physical activity could not be due to coronary patients taking up these occupations after an attack, because many of these occupations require the acquisition of skill and training in early life. To some extent this may also apply to the present study.

The question of whether health has an influence on original occupational choice is a more complex one, as is the question of temperament and occupational choice. These are questions which cannot be answered by the type of study presented here.

We have measured the risk of death from specific causes by computing the standardized mortality ratio (S.M.R.) for an occupation or occupational group, a convention which has become well established in the Registrar-General's reports on occupational mortality.[1] The S.M.R. is a ratio of the observed deaths

*Beginning in 1958, the California death certificate was changed to request "last" occupation, which puts occupational mortality data on the same footing with the Census data.

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in an occupation to the age-standardized expected number of deaths as determined by the age-specific rates for men in all occupations. The method permits comparison of the experience in a subgroup to that of the total group.

The S.M.R. for all men is equal to 100. Some of the death records (4.7 per cent of the total) fail to show a codable occupation. We have not adjusted for the decedents with unknown occupations. Therefore the ratio of observed to expected deaths for all men with reported and codable occupations will range slightly under 100, and this discrepancy will vary according to the specific cause of death. The S.M.R.s for all men with reported occupations are shown as such in each table and indicate the extent to which unknown occupations could have influenced the final results. For example, this influence would be less in the case of coronary heart disease (S.M.R. for reported occupations, 98) than in the case of all causes of death (S.M.R. for reported occupations, 96).

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TABLE I. AVERAGE ANNUAL DEATH RATES PER 100,000 MEN* IN EACH AGE GROUP, CALIFORNIA, 1949 AND 1951

CAUSE OF DEATH	AGE					
	25-29	30-34	35-44	45-54	55-59	60-64
Heart disease specified as involving coronary arteries (420.1)	4.4	10.6	74.5	307.7	603.0	840.8
Arteriosclerotic heart disease, so described (420.0)		1.5	8.2	54.2	139.3	262.7

*Excluding students and active members of armed forces.

The diagnoses classified by the International Statistical Classification, 1948 Revision, include "arteriosclerotic heart disease, so described" (420.0), "heart disease specified as involving the coronary arteries" (420.1), and "angina pectoris without mention of coronary disease" (420.2). The diagnosis of angina as recorded on California death certificates accounted for less than a dozen of the deaths in the group of men considered and therefore this diagnosis is not considered any further in this analysis.

The British occupational mortality statistics usually do not go beyond the over-all designation of arteriosclerotic (including coronary) heart disease, that is, the three-digit I.S.C. code (420) described as coronary disease and angina. We show separately, however, the results for mortality attributed to arteriosclerotic heart disease, so described, and heart disease specified as involving coronary arteries. The latter classification, which includes coronary thrombosis and myocardial infarction, is used in California more frequently at younger ages than is arteriosclerotic heart disease, so described, as shown in Table I. The code designation 420.1 is likely to include somewhat more of the cases fatal at the time of first attack, as indicated by the proportions of deaths certified as 420.0 and 420.1 by coroners who are legally required to investigate sudden

TABLE II. PERCENTAGE OF DEATH CERTIFICATES CERTIFIED BY CORONERS AND OTHERS, CALIFORNIA MEN, AGES 20 TO 64, 1951

CLASSIFICATION	AGE				
	20-64	20-44	45-54	55-59	60-64
Number of deaths due to heart disease specified as involving coronary arteries	6,125	665	2,027	1,586	1,847
Percentage of death certificates certified					
By coroner	46	59	49	42	42
By others	54	41	51	58	58
Number of deaths due to arteriosclerotic heart disease, so described	1,330	75	319	379	557
Percentage of death certificates certified					
By coroner	26	49	29	24	23
By others	74	51	71	76	77

unattended deaths. Table II shows the proportions of deaths certified by coroners to be considerably higher for coronary heart disease than for arteriosclerotic heart disease, so described. Coroners certify a larger proportion of the deaths at younger ages than at older ages for both 420.0 and 420.1; the latter category includes 84 per cent of the deaths in the two classifications.

Numbers of deaths from all causes and each cardiovascular cause are shown in Table III, based on the 3-year period 1949 to 1951. However, information on the tabulating card restricts the analysis of the subclasses 420.0 and 420.1 to deaths during 2 years, 1949 and 1951. Observed and expected numbers of deaths due to coronary heart disease are shown for each specific occupation in Appendix B. Standardized mortality ratios for specific cardiovascular diseases (other than arteriosclerotic and coronary heart disease) are shown for various social classes in Appendix C. Unless otherwise indicated in each table, all mortality ratios are based on at least 50 observed deaths.

In the coding of occupations, use of the Census Bureau Alphabetical Index of Occupations permits listing of 400 to 500 different occupations, depending upon the number of industrial subgroups identified. The necessary cross classifications of occupations by age for California are provided only for the Intermediate Occupational List,[8] which contains a condensed version of 158 occupations, and we have had to modify this somewhat further. Starting with the condensed Intermediate Occupational List results in somewhat crude classifications, as subsequent discussion reveals.

SOCIAL CLASS

The Census Bureau's Intermediate Occupational List[8] was divided into five social classes roughly comparable to the system used by the Registrar-General.

TABLE III. DEATHS FROM ALL CAUSES AND FROM SPECIFIC CARDIOVASCULAR DISEASES, MEN, AGES 20 TO 64, WITH CIVILIAN WORK EXPERIENCE, CALIFORNIA, 1949 TO 1951

CAUSE OF DEATH	NUMBER OF DEATHS
All causes	72,664
Arteriosclerotic heart disease (420)	22,176
Arteriosclerotic heart disease, so described (420.0)	2,701*
Heart disease specified as involving coronary arteries (420.1)	12,004*
Chronic rheumatic heart disease (400-416)	1,670
Other myocardial degeneration (422)	1,159
Hypertensive heart disease (440-443)	2,549
Other heart disease (421, 430-434)	883
Cerebral vascular lesions (330-334)	3,890
Hypertension without mention of heart (444-447)	427
General arteriosclerosis (450)	343
Other circulatory disease (451-468)	656
Chronic and unspecified nephritis (592-594)	830

*For 1949 and 1951 only.

Estimated numbers of California men in the five social classes,* based on the 1950 Census, are: (I) professional, etc., 151,802; (II) intermediate, 523,021; (III) sales, clerical, skilled, 1,058,540; (IV) semiskilled, 657,552; (V) unskilled, 295,961. The population also includes 100,572 farmers, 156,751 farm laborers, and 40,668 men with occupation not reported. The British classify farmers in social class II and most farm laborers in social class IV. In our case, it seems best to show these two groups separately because of evidence that farmers are substantially overreported and farm laborers underreported on California death certificates.[9]

Table IV shows for California a fairly strong and regular social class gradient for mortality from all causes, with the higher S.M.R.s in the less prosperous classes. There is only a slight gradient in the opposite direction for arteriosclerotic and coronary heart disease (420). In contrast, for England and Wales there is an irregular gradient for all causes with a slight excess in the unskilled laboring classes. Moreover, the gradient in the opposite direction for arteriosclerotic heart disease (420) is much stronger in England and Wales than that in California.

When the California data are separated further in Table IV to identify certificates on which involvement of coronary arteries is specified, the slight social class gradient is apparent only for coronary heart disease. No gradient is shown for arteriosclerotic heart disease, so described.

The social class variations in coronary disease are shown in Table V for separate age groups. Age group 55 to 59 years reveals the strongest social class

*We used a classification into five occupational levels which was developed by the National Office of Vital Statistics[11] and which we feel is adequate for the present purpose as an index of social class. While the classification is unlikely to satisfy everyone, it is doubtful that the exchange of a few occupations on the Intermediate List would make important differences in the mortality gradients we found.

gradient downward from I to V, while at the other ages over 45 the gradient is less distinct. At ages under 45 there is no social class trend for coronary heart disease; this is also true for younger men in England and Wales.[1]

Data in Appendix A suggest that a stronger gradient than that actually found in California for the age-standardized mortality ratios at ages 25 to 64 would not have been disguised by errors in reporting last occupations on death certificates. The comparable age-standardized ratios for England and Wales show much more definite evidence of a social class gradient for coronary heart disease mortality, particularly apparent in social class I, than the California data. This lack of agreement does not appear to be due entirely to lack of comparability in social classification of occupations in the two areas. We find general

TABLE IV. STANDARDIZED MORTALITY RATIOS FOR ALL CAUSES AND FOR ARTERIOSCLEROTIC HEART DISEASE, INCLUDING CORONARY DISEASE, MEN AGED 20 TO 64, BY SOCIAL CLASS, CALIFORNIA, 1949 AND 1951, AND ENGLAND AND WALES, 1949 TO 1953

CAUSE OF DEATH	ALL MEN WITH REPORTED OCCUPATIONS*	SOCIAL CLASS†					FARMERS	FARM LABORERS
		I	II	III	IV	V		
California, 1949 and 1951								
All causes	96	87	85	94	98	132	93	90
Arteriosclerotic heart disease, including coronary disease	97	107	105	106	93	89	83	51
Heart disease specified as involving coronary arteries	98	108	107	106	94	84	88	50
Arteriosclerotic heart disease, so described	95	104	92	104	92	104	69	64
England and Wales, 1949 to 1953								
All causes	100	98	86	101	94	118		
Arteriosclerotic heart disease, including coronary disease	100	147	110	105	79	89		

Occupational data for California excludes and for England and Wales includes mortality in armed forces. For source of data for England and Wales see reference 1.

*S.M.R. for all men including unreported occupations is 100.

†Social class excluding farmers and farm laborers: I, professional; II, intermediate; III, sales, clerical, skilled; IV, semiskilled; V, unskilled.

similarity between social class gradients for men in California and in England and Wales for some of the cardiovascular diseases shown in Appendix C and for some diseases to be reported in later publication.

Evidence of a social class trend upward from I to V for mortality from all causes also suggests some success in achieving comparable social class grouping. This gradient as shown in Table VI is rather pronounced. The estimates of bias in Appendix A suggest that, if anything, the true strength of the gradient has been understated. This social class gradient is stronger in the younger age groups. As Table VI shows, the relatively higher general mortality of the skilled and unskilled working classes decreases with age.

TABLE V. MORTALITY RATIOS FOR CORONARY HEART DISEASE (420.1), AGES 25 TO 64, BY SOCIAL CLASS, CALIFORNIA MEN, 1949 AND 1951

AGE GROUP	ALL MEN WITH REPORTED OCCUPATIONS*	SOCIAL CLASS					FARMERS	FARM LABORERS
		I	II	III	IV	V		
25–64†	98	108	107	106	94	84	88	50
25–44†	98	97	100	97	110	104	(95)‡	(42)
45–54	98	105	103	106	96	84	85	54
55–59	98	123	106	107	94	82	78	49
60–64	97	102	114	108	85	78	95	50

*S.M.R. for all men including unreported occupations is 100.
†Age standardized.
‡Numbers in parentheses are based on fewer than 50, but more than 25, observed deaths.

PHYSICAL ACTIVITY

A study reported by Morris and his co-workers[2] in 1953 indicated the incidence of first attack of coronary heart disease to be lower among workers whose jobs required greater physical activity. There was also a lower risk of rapid fatality (that is, within 3 months) from first attack in those who were more active. Furthermore, the active workers relatively more often had the benign form of the disease (angina) than did less active workers. A more recent study by Morris and Crawford,[3] reported in 1958, lends support to the earlier work. In a large series of necropsies, in which death was attributed to causes other than coronary heart disease, men who had held less active jobs more commonly had evidence of severe myocardial damage and coronary occlusion than heavy workers. The association appeared much stronger for ischemic myocardial fibrosis than for occlusion of coronary lumen.[3]

The present examination of the California data on total coronary heart disease mortality is roughly similar to the study by Morris and co-workers[2] in

TABLE VI. MORTALITY RATIOS, ALL CAUSES, AGES 20 TO 64, BY SOCIAL CLASS, CALIFORNIA MEN, 1949 TO 1951

AGE GROUP	ALL MEN WITH REPORTED OCCUPATIONS*	SOCIAL CLASS					FARMERS	FARM LABORERS
		I	II	III	IV	V		
20–64†	96	87	85	94	98	132	93	90
20–34†	95	62	66	77	91	183	136	153
35–44	96	69	76	86	105	171	96	115
45–54	97	90	81	94	102	141	96	89
55–59	96	99	88	99	99	115	87	75
60–64	96	95	96	101	91	107	91	70

*S.M.R. for all men including unreported occupations is 100.
†Age standardized.

which they report an association of physical inactivity with total coronary heart disease mortality, using the Registrar-General's occupational mortality statistics for 1930 to 1932. But it should be noted that they assume these data to be adequate to test the hypothesis that physical inactivity is associated with rapidly fatal coronary heart disease, based on some evidence that at least 70 per cent of total coronary mortality in England and Wales takes place within a month of first attack.

TABLE VII. MORTALITY RATIOS FOR ARTERIOSCLEROTIC AND CORONARY HEART DISEASE, AGES 20 TO 64, ACCORDING TO PHYSICAL ACTIVITY OF OCCUPATION, CALIFORNIA MEN, 1949 AND 1951

CAUSE AND AGE GROUP	ALL MEN WITH REPORTED OCCUPATIONS*	PHYSICAL ACTIVITY				
					HEAVY	
		SEDENTARY	LIGHT	MEDIUM	NONFARM	FARMERS AND FARM LABORERS
All causes, ages 20-64†	96	82	90	99	125	91
Heart disease specified as involving coronary arteries						
25–64†	98	103	107	95	91	69
25–44†	98	85	103	107	97	62
45–54	98	108	106	94	93	68
55–59	98	109	108	99	85	65
60–64	97	99	110	88	92	75
Arteriosclerotic heart disease, so described						
30–64†	95	91	103	95	98	66
30–44†	93	(108)‡	(73)	(106)	(121)	(96)
45–54	94	97	99	93	99	(65)
55–59	96	81	111	97	81	69
60–64	95	92	104	93	104	64

*S.M.R. for all men including unreported occupations is 100.

†Age standardized.

‡Numbers in parentheses are based on fewer than 50, but more than 25, deaths.

Two differences between our data and those of Morris should be mentioned. First, we do not have estimates of what percentage of total coronary mortality in 1950 in California was fatal at or shortly after first attack. Second, there is a considerable time and place difference between the California data for 1949 to 1951 and the British Registrar-General's occupational mortality statistics for 1930 to 1932. Differences in the practice of death certification and changes in statistical classifications of causes of death may influence the statistics.

The California occupations were grouped into four physical activity grades, largely according to a classification originally developed by the United States Employment Service to describe physical demands of jobs for employee placement purposes.[12] The original list gave jobs in some detail and the National Office of Vital Statistics adapted the scheme to the more condensed Intermediate

Occupational List of the Census Bureau. This adaptation is crude because some of the occupational groups on the Intermediate List of 158 titles are combinations of not entirely similar occupations. However, a rough classification should reveal differences in total coronary mortality among occupations of varying physical activity, if true large differences exist. Judging from Morris' results in studying the 1930 to 1932 mortality in 70 occupational groups of social classes III, IV, and V, the coronary mortality rate in light workers would be roughly twice the rate for heavy workers. (It was 2.2 times the rate for heavy workers at ages 45 to 64.)

The estimated population of 2,984,867 men in California aged 20 to 64 in 1950 classified according to physical activity of occupation was as follows: sedentary, 308,706; light, 1,213,406; medium, 756,000; heavy (nonfarm), 408,764; farmers, 100,572; farm laborers, 156,751; occupation not reported, 40,668.

Table VII shows the mortality results for each age group and the result standardized for all ages. No consistent association between physical activity and death attributed to arteriosclerotic heart disease appears for any age group, although farmers and farm laborers have lower mortality ratios than the other groups. For mortality specified as involving coronary arteries, most protection is shown for farm occupations. If farm occupations are left out of the comparison (which might be advocated both because of questionable occupation reporting and because of possible environmental differences, other than physical activity) slight and regular gradients of decreasing coronary mortality with greater physical activity appear only after age 45 and before age 60.

It is not likely that stronger and more regular gradients have been obscured by occupation-reporting bias on death certificates (see Appendix A). The California data for 1949 to 1951 therefore do not show a substantial association of physical inactivity on the job with total coronary mortality in men at all ages up to 64 when nonfarm occupations are considered. The slight association which appears at ages 45 to 59 is certainly not of the magnitude one would anticipate from Morris' study, mentioned earlier, in which light workers at ages 45 to 64 had a mortality rate from coronary disease 2.2 times greater than the rate for heavy workers.

One may speculate about the lack of agreement in the two studies. If there is in England and Wales an association between work activity and *total* coronary disease mortality, the failure to find substantial evidence in the California data may be due to differences in occupational physical activity patterns. Physical activity on the job in California may have been so generally curtailed that only jobs specified as involving "heavy" activity now show any protective effect. We have, of course, ignored the role of physical activity patterns off the job.

On the other hand, the results found using the 1930 to 1932 British data may have reflected an association only between work activity and *rapidly fatal* coronary disease, as suggested by Morris.[2] If so, the association would diminish to the extent that statistics on total coronary mortality do not include as large a portion of the rapidly fatal disease. For example, the California data for 1949 to 1951 may not represent as large a proportion of mortality due to rapidly fatal coronary disease in total coronary mortality as did the England and Wales data

for 1930 to 1932. Conceivably, this could happen through changes in the conventions of death certification and changes in the rules for classifying and tabulating causes of death. Our data do not make possible a decision on the hypothesis that physical activity protects only against coronary disease that is rapidly fatal. To our knowledge the latter hypothesis remains untested in this country.

THE PROBLEM OF THE PRESENCE OF OTHER FACTORS

Real differences which might exist between the physical activity groups may not appear when a large body of routine mortality data is used, as in the present study, to test for an association. It would be preferable to contrast coronary mortality in different physical activity groups only when risk from other etiological factors associated with coronary heart disease is absent or at a minimum. This cannot be said of the occupational mortality data presented above. If physical inactivity was a predominant cause of increased mortality rates from coronary heart disease, we should probably find it in the California data in spite of the presence of other factors. Therefore, that it is not a predominant cause may have been shown by the data presented. On the other hand, if physical inactivity on the job has some lesser but still important role, the answer is still to be sought.

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If, for example, some factor x actually increases the risk of the disease but is uncorrelated with physical activity, the influence of x would be that of reducing a real association between less physical activity and a greater risk of the disease. This is shown in a general way by Cornfield and others.[13] Factor x would have an even more powerful influence in obscuring the association if it was positively correlated with *greater* physical activity of work. The increase in the disease due to factor x would then offset any increase in the disease associated with *less* physical activity of work.

We are unable to observe for physical activity of work while controlling on factors strongly suspected of having an association with the disease, such as diet and cigarette smoking. We do, however, note that greater physical activity of work is strongly associated with increased general mortality risk, and this association is opposite to the expected gradient for coronary disease mortality. Consequently our comparisons in testing for a physical activity gradient in coronary disease mortality have been between sedentary and light workers who are at *low* general mortality risk and medium and heavy workers at *high* general mortality risk. These groups can be made more alike by controlling occupations for mortality due to causes other than coronary and arteriosclerotic heart disease. Over all, these other causes constitute about 70 per cent of total deaths in the California experience and the specified heart diseases about 30 per cent.

The physical activity groups have been made comparable for "other" mortality risk by subtracting numbers of deaths, both observed and expected, due to arteriosclerotic (including coronary) heart disease from the total deaths. This yields S.M.R.s for all causes except the arteriosclerotic cause group. The occupations are then separated into three groups: those with S.M.R.s above 120, those with S.M.R.s of 81 to 119, and those with S.M.R.s of 80 and below—for all other causes. Each of the three groups thus contains occupations with roughly

TABLE VIII. STANDARDIZED MORTALITY RATIOS FOR ALL CAUSES EXCEPT ARTERIOSCLEROTIC HEART DISEASE (420), OCCUPATIONS CLASSIFIED BY THREE LEVELS OF RISK AND BY PHYSICAL ACTIVITY, CALIFORNIA MEN, AGES 20 TO 64, 1949 TO 1951

GENERAL MORTALITY RISK*	ALL NONFARM OCCUPATIONS	PHYSICAL ACTIVITY				FARM
		SEDENTARY	LIGHT	MEDIUM	HEAVY NONFARM	
Total	96	75	82	102	140	103
High general risk	176		138	192	183	
Medium general risk	97	94	92	102	97	
Low general risk	71	71	71	67	70	
Farmers†						98
Farm laborers‡						107

*According to magnitude of S.M.R. (see text).

†Farmers probably overreported on death certificates (see Appendix A).

‡Farm laborers probably underreported on death certificates.

similar mortality risk from other causes. We will refer to this risk as general mortality risk.

Table VIII indicates that the correlation of general mortality risk with increasing physical activity does not prevail in all three general mortality risk subgroups. The unusual pattern in the highest general risk group will be discussed later. We can consider the three groups as general risk groups. The high general risk group contains about 12 per cent of the total population used, the medium risk group about 37 per cent, the low risk group about 40 per cent, and farmers and farm laborers about 11 per cent.

RESULTS WITH GENERAL MORTALITY RISK CONTROLLED

Results are shown in Table IX for coronary heart disease and for arteriosclerotic heart disease, so described, in men ages 45 to 64. It should be recalled that, in these data, the former group constitutes 84 per cent of the total and the latter group 16 per cent.

The top half of Table IX shows results for coronary disease mortality when risk of general mortality in an occupation is controlled. Somewhat less coronary disease mortality occurs in jobs with greater physical activity in both the low and medium general mortality risk groups; there is an irregular gradient in the high general risk group. In addition, the lower half of Table IX reveals a physical activity gradient for mortality attributed to arteriosclerotic heart disease. For this classification of cause of death there had been no indication of a physical activity gradient when general risk was not controlled. Consequently, among occupations of similar general mortality risk, greater physical activity appears to carry protection from mortality due to arteriosclerotic and coronary heart disease.

TABLE IX. STANDARDIZED MORTALITY RATIOS FOR ARTERIOSCLEROTIC AND CORONARY HEART DISEASE, OCCUPATIONS CLASSIFIED BY PHYSICAL ACTIVITY AND BY MAGNITUDE OF RISK FOR OTHER CAUSES, CALIFORNIA MEN, AGES 45 TO 64, 1949 AND 1951

GENERAL MORTALITY RISK*	ALL NONFARM OCCUPATIONS	PHYSICAL ACTIVITY				FARM
		SEDENTARY	LIGHT	MEDIUM	HEAVY NONFARM	
Heart disease specified as involving coronary arteries—Total	101	105	105	98	91	69
High general risk	118		125	157	101	
Medium general risk	106	125	122	94	89	
Low general risk	92	102	94	81	47	
Farmers†						87
Farm laborers‡						51
Arteriosclerotic heart disease, so described—Total	95	91	103	95	98	66
High general risk	130		145	135	115	
Low general risk	89	91	94	79	75	
Farmers†						69
Farm laborers‡						64

*According to magnitude of S.M.R. for all causes except coronary and arteriosclerotic heart disease.

†Farmers probably overreported on death certificates (see Appendices).

‡Farm laborers probably underreported on death certificates.

TABLE X. STANDARDIZED MORTALITY RATIOS FOR CORONARY HEART DISEASE AT AGES 25 TO 44, OCCUPATIONS CLASSIFIED BY PHYSICAL ACTIVITY AND BY MAGNITUDE OF RISK FOR OTHER CAUSES, CALIFORNIA MEN, 1949 AND 1951

GENERAL MORTALITY RISK*	ALL NONFARM OCCUPATIONS	PHYSICAL ACTIVITY				FARM
		SEDENTARY	LIGHT	MEDIUM	HEAVY NONFARM	
Total	101	85	103	107	97	62
High general risk	125		156	(112)†	118	
Medium general risk	107	(97)	107	117	(78)	
Low general risk	89	83	93	90	‡	
Farmers§						(95)
Farm laborers ‖						(42)

*According to magnitude of S.M.R. for all causes except coronary and arteriosclerotic heart disease.

†Numbers in parentheses are based on fewer than 50, but more than 25, deaths.

‡Fewer than 25 deaths.

§Farmers probably overreported on death certificates.

‖Farm laborers probably underreported on death certificates (see Appendix A).

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Table IX also reveals another association. The columns of figures disclose an association of higher coronary disease mortality rates with higher mortality rates for other causes, and this is consistent within each physical activity class. The same association is shown in the bottom half of the table for arteriosclerotic heart disease. Because of the smaller number of deaths attributed to this cause, we have separated occupations into only two groups according to general mortality risk, using an S.M.R. of 100 as dividing point. For all nonfarm occupations the association of general mortality risk with rates for arteriosclerotic heart disease appears even stronger than the association of general mortality risk with rates for coronary heart disease.

By considering the following points one can see why, statistically, the now apparent physical activity gradients had been concealed in the California data and possibly other studies of United States experience:

1. Rates for general mortality increase with greater physical activity on the job as shown in Table VIII, line 1. The association is in the opposite direction to that expected for coronary heart disease, according to Morris' studies.

2. Rates for coronary disease mortality are also associated with rates for general mortality. This elevates the coronary mortality risk in some of the occupations with heavy physical activity.

3. An association of coronary disease mortality with physical inactivity is offset by the association of coronary mortality with general mortality until the latter is controlled.

In the case of coronary disease mortality, its association with general mortality has had the effect of reducing a physical activity gradient in the disease to no apparent importance. In fact, the influence of the association may still be strong enough to account for the fact that the medium physical activity class in the high general risk group has the highest rate for coronary disease (Table IX) and also for mortality from other causes (Table VIII). Occupations contributing most to these excess rates both for coronary disease and other causes are cooks and mine operatives and mine laborers.

General mortality appears to be more strongly associated with arteriosclerotic heart disease, so described, than with coronary heart disease, as shown in column 1, Table IX, and the effect was to conceal completely a physical activity trend for arteriosclerotic heart disease (Table VII).

At ages under 45, where we noted earlier a complete absence of a physical activity gradient (Table VII), the control of general mortality risk still produces no substantial gradient. This is shown in Table X. Physical inactivity has an apparent effect on mortality rates only after age 45. This evidence is of some importance in the analysis of job stress, to be reported later.[17]

While the association of lower coronary mortality rates with heavier work is now found, the question remains whether a common third factor is responsible for the association. This question is pertinent, especially in view of the absence of important differentiation in risk between sedentary and light workers shown in Table IX. Sedentary occupations are largely among social classes I and II and these were not included in Morris' analysis of British mortality data for 1930 to 1932. Among men in sedentary occupations in California, according to

the 1950 Census, 22 per cent reported they were local, state, or federal government workers. Only 11 per cent of those in other occupations were in government employment.

THE APPARENT GENERAL MORTALITY RISK FACTOR

The association between mortality from coronary disease and mortality from other causes, shown in Table IX, suggests that there may be a factor, or factors, common to mortality from a number of diseases including coronary disease. Because general mortality is correlated with greater physical activity, the factor in question must also have this correlation. The presence of such a factor, or factors, may have been responsible for concealment of the physical activity gradients in coronary disease mortality.

Several explanations of the general mortality risk factor occur to us, although none is likely to be the complete answer. First, there may be a greater susceptibility to disease in men who work at heavy jobs, although one wonders whether the demands of heavy work might not preclude the susceptibles. However, an inverse social class distribution of susceptibility is plausible, and a crude classification of physical activity, which grades the occupations rather than the actual work habits of individuals, may not separate those physically fit for active work from those who are forced to remain in a laboring job though unfit.

Second, an occupational factor may influence the chance for survival and thereby increase fatality from coronary heart disease without necessarily affecting the incidence of the disease.

A third possibility is some exogenous hazard perhaps related to coronary heart disease; cigarette smoking might be considered. Several studies, including the recent one by Hammond and Horn,[14] show an association of cigarette smoking with mortality from a number of diseases including coronary heart disease. The question whether cigarette smoking is associated with increased physical activity is less decisively answered. Smoking data from Haenszel, Shimkin, and Miller[15] are available for ten major occupation groups which are only roughly comparable to physical activity class of occupation. Craftsmen, operatives (semiskilled), and general laborer groups have slightly larger proportions of cigarette smokers than are found among professional men, managers, and clerks, but the association is complicated by the fact that laborers report fewer heavy smokers than the managers. It seems possible that an association of cigarette smoking with physical activity of occupation is slightly more pronounced than with social class of occupation. This is suggested by the smoking patterns of craftsmen and operatives, many of whom are classified in heavy physical activity: operatives have the largest proportion of smokers of about a pack a day and proportionately more craftsmen smoke more than a pack a day. These smoking differences are not large, and the estimate from Hammond and Horn[14] of the coronary disease mortality risk due to cigarette smoking ranges only to 2.2:1 for smokers of more than a pack a day (compared to nonsmokers). Consequently, cigarette smoking may have played a role, but only a partial one, in obscuring an association of physical inactivity with coronary mortality.

If there is a factor x common to coronary disease and to other causes of death, it may be at least as important as physical inactivity in accounting for

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increased risk. Over all, the increased risk of coronary heart disease mortality among the high general risk group relative to the low general risk group, as shown in Table IX, is 1.28 (118/92, farm occupations apart). The increased risk for light workers relative to heavy workers is 1.15 (105/91) in the presence of other possible factors. Comparison of nonfarm heavy workers in the high general risk group (S.M.R. 101) with sedentary workers in the low general risk group (S.M.R. 102) indicates that factor x, if it exists, offsets the apparent protection afforded against coronary disease mortality by physically active work. This, plus the fact that the physical activity association is so readily disguised, suggests that if physical inactivity plays a part in determining mortality rates from coronary disease, it is not a dominant one. Of course, this may be true of each etiological factor in the disease.

While the existence of a general mortality factor, or factors, is a strong possibility, some part of the apparent association of coronary mortality rates with general mortality rates might also have been caused by lack of comparability between occupations on death records and on census records. An overstatement of death rates in an occupation would probably be reflected in high mortality rates for all diseases including coronary heart disease and, conversely, occupations with an understatement of deaths would have uniformly low rates. If such errors have helped to produce the association, and concealed the physical activity trends, simple errors in reporting last occupations on death certificates cannot alone have been responsible. Data in Appendix A, referred to earlier, suggest no systematically inaccurate reporting of sedentary-light occupations as medium-heavy occupations on death certificates. However, an underenumeration of an occupation at census time (for example, of seamen) could produce erroneously high rates among medium and heavy workers. We are unable to estimate the extent of this error, which, if it has had any effect, has tended to conceal the physical activity gradient.

GENERAL RISK FACTOR, PHYSICAL ACTIVITY, AND SOCIAL CLASS

When general mortality risk is controlled, the expected gradient of mortality from coronary disease decreasing from social class I to social class V is revealed in more substantial form, as shown in column 1, Table XI. This is not surprising if social class is correlated with physical activity of job. The bottom half of Table XI indicates some, though less substantial, evidence of a social class gradient for mortality described only as due to arteriosclerotic heart disease. The evidence for the latter is totally lacking when general mortality risk is not controlled. Table XI also shows results by cross classification of physical activity and social class, when general mortality risk is controlled. Considerable caution in interpretation is necessary because the numbers of deaths, and of specific occupations, are reduced considerably in some of the cells of the table. The three-way classification may also result in a column or row of occupations in which the grading according to social class or physical activity is weakest. Because of the smaller number of deaths the results may be less definitive for arteriosclerotic heart disease, so described, shown in the bottom half of the table. We will discuss first the results for mortality from coronary disease at ages 45 to 64, shown in the top half of the table.

TABLE XI. STANDARDIZED MORTALITY RATIOS FOR ARTERIOSCLEROTIC AND CORONARY HEART DISEASE, OCCUPATIONS CLASSIFIED BY PHYSICAL ACTIVITY AND SOCIAL CLASS AND BY MAGNITUDE OF RISK FOR OTHER CAUSES, CALIFORNIA MEN, AGES 45 TO 64, 1949 AND 1951

CAUSE OF DEATH, RISK, AND SOCIAL CLASS	ALL NONFARM OCCUPATIONS	PHYSICAL ACTIVITY			
		SEDENTARY	LIGHT	MEDIUM	HEAVY NONFARM
Heart disease specified as involving coronary arteries					
High general risk*	118		125	157	101
Social class I and II	(136)†		(136)		
III	148		161	128	154
IV and V	112		109	167	97
Medium general risk*	106	125	122	94	89
Social class I and II	125	130	122		
III	113	(104)	122	117	92
IV and V	84		120	82	74
Low general risk*	92	102	94	81	47
Social class I and II	104	100	105	‡	
III	91	102	87	81	
IV and V	66		69	78	47
Arteriosclerotic heart disease, so described					
High general risk*	130		145	135	115
Social class I and II	(171)	(171)			
III	129		(167)	(115)	(104)
IV and V	125		125	151	109
Low general risk*	89	91	94	79	75
Social class I and II	93	82	96	‡	
III	97	100	112	72	(89)
IV and V	68		56	85	(49)

*According to magnitude of S.M.R. for all causes except coronary and arteriosclerotic heart disease.
†Numbers in parentheses are based on fewer than 50, but more than 25, observed deaths.
‡Fewer than 25 observed deaths.

Among occupations at low and medium general mortality risk, the heavy workers continue to show the lowest coronary mortality rates when social class level is controlled. However, over *all* physical activity classes some discrepancy appears. In six comparisons within social class at low and medium general mortality risk, ignoring the S.M.R. based on less than 50 deaths, four show progressively decreasing rates with increasing activity, one shows an irregular trend (social classes IV and V, low risk), and one provides inconsistent results between sedentary and light occupations (social classes I and II, low risk). In the apparent inconsistency in social classes IV and V, the low S.M.R. of 69 for light workers is mainly due to the low apparent coronary risk for private household workers, with 9 observed and 37 expected deaths as indicated in Appendix B. We strongly suspect this occupation to be greatly underreported on death certificates, and if the occupation were excluded a consistent trend would emerge, leaving one inconsistent series out of six.

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At high general mortality risk, two comparisons within social class level are possible, neither of which shows fully consistent evidence. We have already pointed out that this high general risk group constitutes only 12 per cent of the total coronary heart disease deaths studied and that the correlation of general mortality risk with greater physical activity has not been as well removed in this group (Table VIII, line 2). While this evidence may be merely insufficient, it is still the case that out of eight possible physical activity gradients within social class, only four, and possibly five, are fully consistent with the hypothesis. The work of Morris and coauthors showed five out of six consistent physical activity gradients at three social class levels in each of two age groups, using total coronary mortality data for 1930 to 1932,[2] and three out of five fully consistent at social class levels, using necropsy data on myocardial infarctions in noncoronary deaths during 1954 to 1956.[3] The strength of the physical activity gradients is greater in the British material.

It is, of course, not a question of whether there is an association with physical activity, but whether the association is due to some other cause. Both the California material and that for England and Wales are consistent with the hypothesis that physical activity of work may be a real cause in the variation of coronary disease rates, but the question is certainly not a closed one and the California material is less decisive.

Results for arteriosclerotic heart disease, so described (Table XI, lower half), are considerably more irregular than when social class is not controlled. Morris and Crawford[3] have shown that the association with physical activity is quite substantial for myocardial infarction, moderate for complete or nearly complete occlusion, and not present for lesser narrowings of the coronary arteries. The distinction these authors make between ischemic heart disease and coronary artery disease would not lead us to expect noticeable associations with the statistical classification of arteriosclerotic heart disease, so described.

DISCUSSION

Several studies in this country have failed to confirm the findings from England and Wales of a greater risk of mortality from coronary disease for men in higher social classes and for sedentary-light workers compared to more active workers. Lilienfeld,[4] Katz, Stamler, and Pick,[5] and Kent and co-workers[6] found no social class gradients when analyzing arteriosclerotic (including coronary) heart disease by census tracts or health areas in several metropolitan areas. Katz and Stamler also looked at mortality from these diseases by broad occupational groups in Chicago and failed to find a lower rate for heavy workers. However, total mortality from all causes was not considered in these studies. The California data for 1949 to 1951 show that occupations of apparently similar general mortality risk have the expected social class and physical activity gradients for coronary heart disease.

Census tract data might also show a social class gradient when general mortality risk is controlled. Residence in the slum areas of a city, where heart disease mortality appears to be high in the studies mentioned above, also carries a high mortality risk from all causes. This would be especially true in large metropolitan areas.

The results from the three previous United States studies cited above are frankly unlike the British results. The California results, while showing social class and physical activity gradients similar to those in the British studies, are dissimilar in that the gradients in California can be seen clearly only by controlling on general mortality risk. Inspection of the British data on general mortality by social class suggests one reason for this.

Table XII shows the social class variations in general mortality risk both in California and in England and Wales. We have combined social classes I and II and social classes IV and V to minimize possible differences in social classification of occupations in the two areas. For each decennial age group from 25 to 64 years, the excess of general mortality in social classes IV and V over social classes I and II is greater in California than in England and Wales. The relative difference would be even greater if social classes I and V only were compared. The National Office of Vital Statistics has shown this in a social class comparison of the United States as a whole with England and Wales.[11] This indicates that the British analysis has contrasted social classes that are somewhat more alike on general mortality risk than the California social classes. There also appears to be a greater similarity in mortality from most causes except coronary disease between the physical activity groups analyzed by Morris and Heady.[16] A weaker gradient of general mortality risk both with social class and with physical activity in England and Wales permits the gradients in the opposite direction for coronary heart disease mortality to be more readily discerned. The problem is a complex one, however, and other differences may also account for the more apparent associations with coronary disease mortality in England and Wales than in the United States.

TABLE XII. RELATIVE DIFFERENCES IN SOCIAL CLASS MORTALITY FROM ALL CAUSES, AVERAGE ANNUAL RATES PER 100,000 MEN, CALIFORNIA, 1949 TO 1951, AND ENGLAND AND WALES, 1949 TO 1953

AGE GROUP	SOCIAL CLASS*		RATIO OF IV AND V / I AND II
	I AND II	IV AND V	
25-34			
California	144	254	1.76
England and Wales	124	180	1.45
35-44			
California	332	529	1.59
England and Wales	226	332	1.47
45-54			
California	938	1,232	1.31
England and Wales	712	895	1.26
55-64			
California	2,249	2,795	1.24
England and Wales	2,097	2,339	1.12

*Farmers are included in social classes I and II; farm laborers are included in social classes IV and V.

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The recorded mortality data used here will not answer the question whether a limitation of physical activity is a real cause of coronary heart disease. Nor will it even provide a good estimate of the strength of the association between the two—except to show that it is not strong relative to other causes. The difficulty lies not alone in the crude method of classifying physical activity, which probably understates the magnitude of the association because extremes of physical activity are not clearly isolated; there is difficulty also in the use of death certificate diagnoses of heart disease. The latter includes both the problem of misdiagnosis and the problem of singling out quite distinct pathologic entities such as myocardial infarction. If the quality of death certificate diagnosis differs between occupations, an apparent association might thereby be explained. If the quality is poor, as we suspect, but uniformly poor, it is more difficult to detect the association we are studying. Since there are sufficient reasons to suspect that there is dilution both in the classification of "cause" (physical inactivity) and in the classification of "effect" (coronary heart disease), the moderate findings reported here may represent something important.

The apparent degree of association found in California can be compared to that found in England and Wales, although the result is not easy to evaluate. The available comparison is with the study by Morris and others[2] dealing with total coronary mortality data for 1930 to 1932. There may well have been considerable change in the practice of diagnosing and classifying causes of death since 1930 to 1932, as suggested by the following. At that time 21 per cent of degenerative heart disease deaths were coded to coronary heart disease and 79 per cent to "other myocardial degeneration" (currently I.S.C. code 422) in the population studied by Morris, that is, men aged 35 to 64 in social classes III, IV, and V. In 1949 to 1953 the same groups in England and Wales had percentages of 82 and 18, respectively, representing a dramatic increase in the proportion of deaths attributed to coronary heart disease, for one reason or another. (In California, 1949 to 1951, the percentages were 95 and 5.) Some of the large proportion of deaths currently attributed to coronary heart disease may be cardiovascular disorders not related to physical activity. With this in mind, the California material for 1949 to 1951 showed an excess of coronary disease mortality in sedentary workers over heavy workers of about 40 per cent (in the medium general risk group) compared to the twofold excess found in England and Wales for 1930 to 1932. It will be interesting to see whether any reduction in the latter figure is revealed when the analysis by physical activity is completed on the recent British occupational data for 1949 to 1953.

SUMMARY

A gradient of decreasing mortality rates from coronary heart disease with increasing physical activity of work in middle-aged men, reported from England, is confirmed under special conditions in California data for 1949 to 1951. The California gradient is clearly revealed only in contrasts between occupational groups of similar general mortality risk. The evidence for a social class gradient of coronary mortality in California is revealed in the same way, although it too is readily apparent in British studies without controlling general mortality risk.

Earlier studies in the United States, which failed to confirm British results, have not included an analysis of general mortality.

The apparently greater risk of coronary mortality in sedentary workers compared to heavy workers is of moderate degree, about 40 per cent for occupations at average general mortality risk in the California data. Factors which increase the general mortality risk, and which had obscured the physical activity association, seem to account for as much coronary mortality as that possibly attributed to a limitation of physical activity in work.

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APPENDIX A

Occupation-Reporting Bias

The numerator and denominator of the standardized mortality ratios appear to lack comparability because the death certificate calls for the longest-held occupation while the Census enumerates the last occupation. This problem is lessened somewhat by evidence, first reported elsewhere,[9] showing that in fact last occupations are reported extensively on the death certificates. The following table shows that failure to report the actual last occupation on death certificates might produce serious distortions in mortality ratios only for farmers and farm laborers and possibly lesser distortions in social classes I and IV. But this is only one side of the problem, and we are not able to estimate possible inaccuracies in mortality ratios due to census underenumerations in an occupation.

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The possible influence of occupation-reporting bias as defined here must be estimated with caution. The data[9] are based on occupational histories from a small sample of lung cancer patients whose death certificates were later obtained. The group is hardly representative of the total population studied.

Estimates of reporting bias, as it may affect S.M.R.s for coronary heart disease, are more appropriately applied to the physical activity and social class gradients observed before general mortality risk is controlled. Column 3 of the following table shows that trends in bias are contrary to the possibility that stronger gradients of coronary heart disease mortality have been weakened from this source alone. On the other hand, the danger of accepting falsely even a weak social class gradient for I to IV is suggested, though social class V would have mortality ratios apparently unaffected by bias.

When observing the coronary mortality risk with general mortality risk controlled, the possible influence of occupation-reporting bias would be altered. Each level of general mortality risk contains a series of occupations of somewhat similar status on occupation misreporting with regard to all causes. Occupations with the highest inaccurate S.M.R.s are separated from those with the lowest inaccurate S.M.R.s, so that the effect of bias is minimized within each level of general mortality risk. Our conclusion that social class and physical activity gradients of coronary disease mortality are present depends on control of general mortality risk.

DEATH CERTIFICATE OCCUPATION-REPORTING BIAS AS IT AFFECTS OCCUPATIONAL GROUPINGS

CLASSIFICATION	NUMBER FROM OCCUPATIONAL HISTORY	NET EFFECT OF BIAS		NUMBER ON DEATH CERTIFICATE SAME AS THAT FROM OCCUPATIONAL HISTORY†	
		NUMBER ON DEATH CERTIFICATE	PER CENT*	NUMBER	PER CENT
	(1)	(2)	(3)	(4)	(5)
Social class					
I	11	14	127	11	100
II	26	26	100	21	81
III	113	122	108	99	88
IV	91	72	79	59	65
V	47	48	102	35	74
Farmers	6	11	183	5	83
Farm laborers	10	4	40	3	30
Unknown	0	7	—	—	—
Total	304	304		233	
Physical activity					
Sedentary	15	15	100	12	80
Light	103	109	106	91	88
Medium	110	95	86	83	75
Heavy (nonfarm)	60	65	92	52	87
Farmers	6	11	183	5	83
Farm laborers	10	4	40	3	30
Unknown	0	7	—	—	—
Total	304	304		246	

*Ratio of number reported on death certificate to number ascertained by history (columns 2/1 = 3). Column 3 suggests the variation of an S.M.R. from a value of 100 due to occupation-reporting bias.

†The ratios shown in column 5 (4/1 = 5) will suggest whether an actual S.M.R. reflects all that it should; for example, if the S.M.R. for a disease in social class V is greater than 102 (column 3), only 74 per cent (column 5) of the true excess is reflected in the S.M.R. (see reference 9).

APPENDIX B

Observed and Expected Numbers of Deaths From Coronary Heart Disease in Occupations Classified by Level of General Mortality Risk, Social Class, and Physical Activity, California Men, Ages 25 to 64, 1949 and 1951

GENERAL RISK GROUP* AND SOCIAL CLASS	TOTAL		PHYSICAL ACTIVITY											
	OBSERVED	EXPECTED	SEDENTARY	OBSERVED	EXPECTED	LIGHT	OBSERVED	EXPECTED	MEDIUM	OBSERVED	EXPECTED	HEAVY	OBSERVED	EXPECTED
High general risk	1,714	1,444.3					447	348.4		422	276.2		845	819.7
Social classes I and II	44	34.3				16 Musicians, music teachers	44	34.3						
Social class III	310	216.1				76 Stationary engineers	136	85.4	49 Bakers	44	35.2	50 Blacksmiths, forgemen	27	16.2
									62 Locomotive firemen	5	7.8	51 Boilermakers	29	19.5
									84 Brakemen, railroad	40	31.9	77 Structural metal workers	29	20.2
Social classes IV and V	1,360	1,193.9				88 Laundry, dry cleaners operators	47	45.0	127 Cooks, except private household	206	136.1	140-157 Laborers†	635	663.0
						98 Taxicab drivers	75	41.6				137 Longshoremen, stevedores	51	48.1
						128 Elevator operators	23	19.6	90 Mine workers	127	65.2	138 Lumbermen, etc.	37	31.4
						132 Waiters, bartenders	122	122.5				94 Sailors, deck hands	37	21.3
Medium general risk	4,432	4,171.1		230	188.7		2,069	1,721.6		1,552	1,603.4		581	657.4
Social classes I and II	623	511.4	1 Accountants	174	132.9	2 Architects	18	12.2						
			3 Artists, etc.	21	19.9	4 Authors, editors, etc.	41	35.6						
						5 Chemists	17	14.1						
						6 Clergymen	51	40.8						
						8 Dentists	38	29.3						
						18 Pharmacists	51	32.9						
						24 Technicians, medical and dental	16	10.4						
						25 Other professional, technical	196	183.2						
Social class III	2,720	2,422.6	39 Bookkeepers	35	36.0	43 Real estate agents, brokers	213	124.5	55 Cranemen, hoistmen, etc.	47	55.9	64 Masons, tile setters	27	32.0
						44 Other specified sales workers	31	37.8				69 Millwrights	12	10.2
						45-48 Salesmen†	653	581.7	56 Electricians	144	117.6	73 Plumbers and pipefitters	115	103.4
						54 Compositors, typesetters	73	50.0	63 Machinists, job setters	245	179.9	53 Carpenters	353	415.4
						61 Locomotive engineers	44	26.4	66 Mechanics, automobile	148	166.1			
						67 Mechanics, radio and TV	20	17.4	70 Molders, metal	10	11.7			
						75 Shoemakers, not factory	17	22.6	129 Firemen, fire protection	66	35.6			
						78 Tailors, furriers	57	37.1						

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						81 Other craftsmen	165	172.1						
						91 Motormen, street, subway	16	8.6						
						130 Guards and watchmen	116	108.5						
						131 Policemen, sheriffs	113	72.4						
Social classes IV and V	1,089	1,237.2				97 Stationary firemen	21	19.1	71 Painters, construction	225	205.9	87 Furnacemen	4	7.4
						125 Barbers, beauticians	102	85.1	89 Meat cutters	67	56.4	136 Fishermen, oystermen	28	31.3
									100 Welders, flame cutters	75	55.8	72 Plasterers, etc.	42	57.6
									126 Janitors	149	259.2			
									133 Other service workers	124	180.7			
									99 Truck drivers, etc.	252	278.7			
Low general risk	4,558	4,967.8		976	982.2		2,985	3,184.1		514	627.4		83	174.1
Social classes I and II	2,532	2,440.6	7 College faculty members	7	27.0	10 Engineers, aeronautical	9	11.3	22 Surveyors	8	9.3			
			9 Designers, draftsmen	27	32.1	11 Engineers, civil	60	61.1						
			15 Lawyers, judges	61	56.1	12 Engineers, electrical	30	32.6						
			20 Social scientists	6	6.9	13 Engineers, mechanical	35	36.3						
			27 Officials, state and local	50	56.8	14 Other technical engineers	46	45.4						
			29, 34 Managers, manufacturing	276	250.7	17 Natural scientists	13	10.4						
						19 Physicians and surgeons	64	61.3						
						21 Social welfare workers	9	11.7						
						23 Teachers†	65	70.5						
						28 Other specified managers	217	215.6						
						30, 35-37 Managers, trade	799	787.6						
						31-33, 38 Managers, other industries	750	658.0						
Social class III	1,283	1,420.7	41 Other clerical workers	549	552.8	42 Insurance agents, brokers	101	85.5	52 Cabinetmakers	37	50.2			
						57 Foremen, manufacturing durable	38	52.1	60 Linemen, servicemen	30	51.6			
						58 Foremen, manufacturing nondurable	34	41.2	65 Mechanics, airplane	21	43.3			
						59 Foremen, nonmanfacturing industries	104	129.9	68 Other mechanics	262	299.4			
						74 Printing craftsmen	23	27.2	79 Tinsmiths, coppersmiths	47	44.2			
						93 Power station operators	4	8.6						
									80 Toolmakers, die makers	33	34.6			
Social classes IV and V	743	1,106.5				83 Attendants, auto service	34	38.5	40 Mail carriers	40	40.2	139 Other specified laborers	83	174.1
						86 Filers, grinders, metal	14	21.3	82 Apprentices	1	9.1			
						92 Painters, except construction	24	29.1	85 Bus drivers	26	30.4			
						96 Spinners, weavers	1	1.2	95 Sawyers	9	15.0			
						101 Other specified operatives	35	49.3						
						102-123 Operatives†	467	661.3						
						124 Private household workers	9	37.0						

Observed and expected numbers for farmers, 569 and 649.6; farm laborers, 318 and 629.5; occupation not reported, 413 and 142.2. Expected numbers rounded after totaling. The correspondence between Intermediate Occupational Code numbers, shown above, and the Detailed Occupation Code numbers can be found in the U. S. Bureau of the Census: Characteristics of the Population, 1950, Vol. II, U. S. Summary, Part 1, p. 53.

*General risk refers to standardized mortality ratio for all causes except arteriosclerosis and coronary heart disease (420). High, 120 and over; medium, 119 to 81; low, 80 and under.

†Not elsewhere classified.

APPENDIX C

Standardized Mortality Ratios for Specific Cardiovascular-Renal Diseases, Ages 20 to 64, by Social Class, California Men, 1949 to 1951

DISEASE	ALL MEN WITH REPORTED OCCUPATIONS*	SOCIAL CLASS					FARMERS	FARM LABORERS
		I	II	III	IV	V		
Arteriosclerotic heart disease, including coronary disease (420)	97	107	105	106	93	89	83	51
Other myocardial degeneration (422)	95	(85)†	63	90	103	143	105	121
Chronic rheumatic heart disease (400-416)	97	104	85	102	99	105	95	73
Hypertensive heart disease (440-443)	96	82	84	96	99	136	87	71
Other diseases of the heart (421, 430-434)	96	(77)	65	93	103	146	122	(97)
Cerebral vascular lesions (330-334)	96	107	103	96	85	111	110	59
Hypertension without mention of heart (444-447)	99	(105)	99	98	94	118	(114)	(64)
General arteriosclerosis (450)	96	(91)	97	92	93	136	(82)	(79)
Other diseases of circulatory system (451-468)	97	(111)	101	87	97	140	(79)	(64)
Chronic and unspecified nephritis (592-594)	97	(116)	105	94	77	126	(130)	(68)

Social classes excluding farmers and farm laborers: I, professionals; II, managers, officials, technicians; III, sales, clerical, skilled; IV semiskilled; V, unskilled.

*S.M.R. for all men including unreported occupations is 100.

†Numbers in parentheses are based on fewer than 50, but more than 25, observed deaths.

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MULTIDISCIPLINARY STUDIES OF ILLNESS IN AGED PERSONS
III. Prognostic Indices in Fracture of the Hip

STAFF OF THE BENJAMIN ROSE HOSPITAL*
CLEVELAND, OHIO

From The Benjamin Rose Hospital and from the Departments of Medicine and Preventive Medicine, School of Medicine, Western Reserve University, and the University Hospitals

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THE staff of The Benjamin Rose Hospital, a hospital for patients with prolonged illness in Cleveland, Ohio, has been making a continuing effort to study the course of chronic illness.[1,2] Study data, including physical, social, and psychologic information, are accumulated throughout the courses of specific illnesses. Results are then used to extend the known information about specific disease and to evolve improved techniques for the study of chronic illness.

This report is concerned with the development of prognostic indices in patients admitted with fracture of the hip to The Benjamin Rose Hospital. Age, cardiac status, hospital nursing time requirement, and intelligence test results were prognostically related to mortality and to deterioration in activities of daily living, in walking, and in nature of residence. Additional evaluations dealt with the relationship between disability prior to injury and deterioration observed in 1-year follow-up evaluations, as well as the relationship between disability prior to injury and clinically evident rheumatoid arthritis or previous cerebral infarction. Finally, the significance of the observations was reviewed.

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*Sidney Katz, M.D., and Austin B. Chinn, M.D. (principal investigators); Arthur S. Litteli, Sc.D. (biostatistician); Robert C. Grotz, M.A., Kingsbury G. Heiple, M.D., Malcolm S. Mackenzie, M.D., William B. Newberry, M.D., and Alexander P. Orfirer, M.D. (medical, surgical, and psychiatric investigators); Marjorie W. Jaffe, B.A., M.A. (coordinator); Allice Kelly, A.B., M.S.S.A., Ruth E. Mason, A.B., M.S.S.A., and Margaret B. Ryder, A.B. (social service investigators); Marion Bittman, R.N., Cleo C. Conley, R.N., H. Jean Holman, R.N., Jacquelyn A. Millen, R.N., Bonita P. Rice, R.N., Lavina M. Robins, R.N., and Mary A. Sherback, R.N. (nursing investigators); Susan W. Ritchie, O.T.R., and Stephen J. Takacs, R.P.T. (occupational and physical therapy investigators).

METHODS

Benjamin Rose Hospital patients in the study included all private and staff patients admitted with fracture of the hip within 6 months prior to admission. Patients in the current study were admitted between September, 1956, and September, 1958. The present report includes the results of 6-month evaluations in 90 consecutive patients and 1-year evaluations in the first 82 of these.

The methods used to accumulate and record comparable physical, psychologic, and social data were introduced in detail previously.[1] Course of illness was evaluated by comparing 6-month or 1-year status with status prior to fracture and was expressed using the proportion of patients who showed deterioration. The latter was defined as a change from a given status to a more dependent one, and the specific definitions of dependence and independence are indicated in the following paragraph.

Status in activities of daily living was evaluated by the "Index of Independence in Activities of Daily Living (Index of ADL)," a graded index based on the functional independence or dependence of patients in bathing, dressing, going to toilet, transferring, continence, and feeding.[2] Details of the grading and definitions of the Index of ADL are given below. The function of walking was considered separately and was not included in the Index of ADL. Deterioration in walking was defined as a change to a state of greater dependence according to the following classification: walking by self or with mechanical aids, walking with personal assistance, and not walking. Mechanical aids were defined to include canes, crutches, walkers, and other objects for support, while types of personal assistance included direction, supervision, and active personal assistance. Patients receiving personal assistance may or may not have been using mechanical aids as well. Deterioration in residence status was defined as a change from living in a house, apartment, or hotel to a hospital, institution, or nursing-type home.

Age at the last birthday prior to the time of occurrence of the fracture was used in the age classification of patients. Nursing time requirement was defined as the average daily time (to the nearest quarter hour) devoted by the nursing staff to patients in assisting the functions listed in the Index of ADL. Based on time studies of nurses and aides who assisted in these functions, patients were divided into two groups. The first group, termed the "one-fourth hour or less group," included patients who received an average of one-fourth hour or less of daily nursing aid with regard to the indicated functions during the ninth and tenth weeks after fracture. Patients discharged prior to the tenth week after fracture were included in the one-fourth hour or less group if they had achieved 2 consecutive weeks in which they received an average of one-fourth hour of daily nursing aid or less. The second group, termed the "one-half hour or more group," included patients who received an average of one-half hour or more of daily nursing aid in the ninth and tenth weeks after fracture. Patients not observed during the ninth and tenth weeks were considered as not classifiable if they had not achieved the state of self-sufficiency represented by an average of one-fourth hour or less of daily nursing aid for 2 weeks. The cardiac classification of patients was based on the presence or absence of congestive failure (signs, symptoms,

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and digitalis requirement) or electrocardiographic evidence of recent or remote myocardial infarction. Intelligence test results were obtained by the use of the Wechsler Adult Intelligence Scale.[3]

INDEX OF INDEPENDENCE IN ACTIVITIES OF DAILY LIVING

The Index of Independence in Activities of Daily Living is based on an evaluation of the functional independence or dependence of patients in bathing, dressing, going to toilet, transferring, continence, and feeding. Specific definitions of functional independence and dependence appear below the index.

A—Independent in feeding, continence, transferring, going to toilet, dressing, and bathing
B—Independent in all but one of these functions
C—Independent in all but bathing and one additional function
D—Independent in all but bathing, dressing, and one additional function
E—Independent in all but bathing, dressing, going to toilet, and one additional function
F—Independent in all but bathing, dressing, going to toilet, transferring, and one additional function
G—Dependent in all six functions
Other—Dependent in at least two functions, but not classifiable as C, D, E, F, or G

Definitions.—Evaluation of bathing is made in relation to either sponge, shower, or tub bathing. Patients are classified as independent if they perform the function without supervision, direction, or active personal assistance. Patients are also classified as independent if they receive such assistance in bathing only a single part of the body such as the back only or the disabled extremity only. A designation of dependent status is made in patients who receive assistance in bathing more than one localized part of the body or in getting in or out of the tub. Patients who do not bathe themselves at all are classified as dependent.

Evaluation of dressing is made in relation to getting clothes from closets and drawers, as well as in relation to the act of putting on clothes. Clothes include underclothes, outer garments, fasteners, and braces if the latter are worn. The specific act of tying shoes is excluded from the evaluation. Patients are classified as independent if they perform the function without supervision, direction, or active personal assistance. A designation of dependent status is made in patients who receive such personal assistance or who remain partly or wholly undressed.

Evaluation of going to toilet is made in relation to the act of getting to the toilet for purposes of excretion, as well as getting on and off the toilet, arranging clothes, and cleaning organs of excretion. Patients are classified as independent if they perform the function without supervision, direction, or active personal assistance. It should be noted that patients in the independent class may or may not be using mechanical aids such as wheel chairs, canes, walkers, or other objects for support. A designation of dependent status is made in patients who receive any of the indicated personal assistances or who do not perform the function. Status is considered dependent in patients who do not go to the room termed "toilet" and instead use containers such as bedpans or commodes.

Evaluation of transfer technique is made in relation to movement of patients in and out of bed and in and out of chair. Patients are classified as independent if they perform all these functions without supervision, direction, or active personal assistance. Patients in the independent class may or may not be using mechanical aids such as arms of chair, bedposts, wall handles, canes, walkers, trapezes, or other objects for support. A designation of dependent status is made in patients who receive any of the personal assistances in any of the transfers or who do not perform one or more of the transfers.

Continence status is classified as independent if urination and defecation are entirely self-controlled. A designation of dependent status is made in those who exhibit partial or total incontinence in either function. Status is also considered dependent if continence is controlled partly or wholly by others by such means as enema, catheterization, or regulated use of urinals or bedpans.

Evaluation of feeding is made in relation to getting food from a plate or its equivalent into the mouth. The precutting of foods such as meat and the preparation of foods are excluded from the evaluation. Patients are classified as independent if they perform the function without supervision, direction, or active personal assistance. A designation of dependent status is made in patients who receive such personal assistance. Patients who do not eat at all or who receive tube or parenteral feedings are classified as dependent.

Note.—The functional classification of patients is based on actual status and not on ability. Thus, for example, a patient who refuses to perform a function is considered as not performing the function though he is deemed able. In the practical application of the index, a constant effort must be made to remember that supervision of a function or part of a function is considered dependency.

RESULTS

A study was made of functional deterioration and mortality according to age, daily nursing time requirement, cardiac classification, and intelligence class (Table I). (Details of definitions of these terms are presented in the section on Methods.) Deterioration was evaluated by comparing both 6-month and 1-year status with status prior to fracture. Deaths were excluded except in the calculation of mortality; thus quantitative expressions of deterioration referred to patients who survived the interval of evaluation. Certain patients were in a deteriorated residence status prior to fracture and were excluded from calculations of deterioration in residence because there was no lower classification. Deterioration in activities of daily living, in walking, and in residence were evaluated by the Index of ADL, grades of walking, and definitions of residence status as previously described.

The frequencies of occurrence of functional deterioration and mortality were compared in groups of patients classified according to age (Table I). The frequency of deterioration in activities of daily living increased with increasing age in patients 70 years old or older. Noteworthy was the relatively large proportion of ADL deterioration observed among patients in the youngest age group, i.e., two-fifths of the 50- to 69-year-old patients within 6 months and 1 year after the occurrence of the fracture. The proportions of patients whose walking ability deteriorated increased with increasing age. All but 1 of the 60- to 79-year-old patients were walking independently at 1 year, while more than 40 per cent of those in the 80 to 99 years age group were receiving supervision or assistance. Two of 7 in the 50- to 59-years-old group were receiving supervision or assistance. Deterioration in residence tended to increase in frequency at 6 months with increasing age in patients less than 90 years old. Evaluation beyond this age was clouded by the small number in this age group. Significant differences were not demonstrated in mortality or in deterioration in residence at 1 year.

The frequencies of occurrence of functional deterioration and death were compared in groups of patients classified according to the amount of nursing time received in relation to the Index of ADL during the ninth and tenth weeks after fracture (Table I). Individuals receiving more nursing time had greater deterioration rates and greater mortality rates than the individuals receiving less nursing time at both 6 months and 1 year. All the differences except those involving deterioration in residence were significant ($P < 0.05$). At 6 months,

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the proportions of deterioration in the one-half hour or more group were 71 per cent in relation to the Index of ADL and 48 per cent in relation to walking. The corresponding proportions of deterioration were similar at 1 year. Mortality in the one-half hour or more group was 11 and 27 per cent at 6 months and 1 year, respectively, while mortality in the one-fourth hour or less group was correspondingly 0 and 2 per cent.

TABLE I. FUNCTIONAL DETERIORATION ACCORDING TO AGE, DAILY NURSING TIME REQUIREMENT, CARDIAC CLASSIFICATION, AND INTELLIGENCE CLASS IN PATIENTS ADMITTED WITH FRACTURE OF THE HIP TO A HOSPITAL FOR PROLONGED ILLNESS

DETERIORATION CATEGORY	PER CENT OF PERSONS WHO DETERIORATED						PER CENT WHO DIED	
	IN ADL INDEX*		IN WALKING*		IN RESIDENCE*			
	6 MO.	1 YR.	6 MO.	1 YR.	6 MO.	1 YR.	6 MO.	1 YR.
Age (years):								
50–69	41	38	6	6	0	0	6	11
70–79	31	24	12	5	15	10	4	9
80–89	61	61	39	39	35	22	8	18
90–99	100 †	100 †	57 †	50 †	14 ‡	17	13	14
Nursing time requirement*:								
One-fourth hour or less	41	40	20	13	14	9	0	2
One-half hour or more	71 ‡	74 ‡	48 ‡	47 †	29	24	11 ‡	27 ‡
Heart failure or infarct*:								
Absent	48	43	21	16	16	11	4	11
Present	61	67	44	40	35	20	14	21
Intelligence quotient (by WAIS)*:								
110 or more	20	30	0	0	10	20	0	0
90 to 109	50	44	23	12	19	8	4	7
89 or less	54	46	0	8	15	8	7	7
Testing unsuccessful	86	100	83 †	100 †	20	50	13	38 ‡

*See text for detailed definitions of deteriorations and classifications. Deterioration was evaluated by comparing 6-month or 1-year status with status prior to fracture. Certain patients were in a deteriorated residence status prior to fracture and were excluded from the calculation of deterioration percentages because there was no further deterioration classification. Deaths were excluded except in the calculation of mortality; thus, deterioration refers to survivors.

†Comparison of differences in the numbers of persons in this section by the chi square test revealed significant differences at the 0.01 level of probability.

‡Comparison of differences in the numbers of persons in this section by the chi square test revealed significant differences at the 0.05 level of probability.

The frequencies of occurrence of functional deterioration and death were compared in patients classified according to the presence or absence of congestive heart failure or recent or remote myocardial infarction (Table I). The proportions of deterioration and mortality were greater among patients with at least one of the cardiac complications than among those without either of them; however, the differences were not statistically significant.

The frequencies of occurrence of functional deterioration and death were compared in groups of patients classified according to intelligence tests results on the Wechsler Adult Intelligence Scale (Table I). Patients with lower intelligence quotients deteriorated more frequently in activities of daily living at both 6 months and 1 year, but the differences were not significant. Testing was tried and was unsuccessful in a small number of patients who were either psychotic or aggressively hostile in refusing testing. Although the number of patients in this group was small, results of follow-up evaluations were included in Table I for the sake of completeness. It was of interest to note that the proportions of deteriorations and mortality in this group were greater than in the groups that were successfully tested. In fact, the significant differences relative to deterioration in walking and mortality rates were attributable to the large proportions of deterioration in the unsuccessfully tested group.

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TABLE II. DETERIORATION IN ACTIVITIES OF DAILY LIVING, BY AGE, ACCORDING TO PRESENCE OR ABSENCE OF DISABILITY PRIOR TO FRACTURE IN PATIENTS ADMITTED WITH FRACTURE OF THE HIP TO A HOSPITAL FOR PROLONGED ILLNESS

AGE RANGE (YEARS)	PER CENT OF PATIENTS SHOWING DETERIORATION IN INDEX OF ADL 1 YEAR AFTER FRACTURE*	
	AMONG PATIENTS WITHOUT DISABILITY PRIOR TO FRACTURE†	AMONG PATIENTS WITH DISABILITY PRIOR TO FRACTURE†
50–69	22	57
70–89	39	75
90–99	100‡	100‡

*See text for detailed definitions of deterioration as evaluated in relation to bathing, dressing, going to toilet, transferring, continence, and feeding. Deterioration was evaluated by comparing 1-year status with status prior to fracture.

†Disability referred to any disability with regard to the Index of ADL. Deaths were excluded in the calculation; thus, deterioration refers to survivors.

‡These percentages were based on small numbers of persons (2 and 4) in this age category.

A preliminary effort was made to discover possible causes for the commonly occurring deterioration in young patients, and the following relationships were noted. In the 50 to 69 and 70 to 89 years age groups, patients who had ADL disability prior to fracture deteriorated more commonly than patients without disability prior to fracture (Table II). In the 90 to 99 years of age group, all deteriorated. Disability prior to fracture was most frequent in the youngest and oldest patients, i.e., present in 8 (44 per cent) of 18 patients aged 50 to 69 years, in 17 (27 per cent) of 64 patients aged 70 to 89 years, and in 3 (38 per cent) of 8 patients aged 90 to 99 years (Table III). In the youngest age group, furthermore, disability prior to fracture was closely related to the presence of rheumatoid arthritis or prior stroke (Table III). In this age group, 6 of the 8 with

disability prior to fracture had prior stroke and the remaining 2 had rheumatoid arthritis, while only 1 of the 10 without prior disability had either of these complications.

DISCUSSION

Methods used in the present continuing study of course of illness were described in earlier reports.[1,2] Preliminary results in the first report dealt with 6-month evaluations in 20 consecutive patients admitted with fracture of the hip to The Benjamin Rose Hospital, a hospital for prolonged illness in Cleveland, Ohio.[1] Differences in the course of illness were compared in groups of patients

TABLE III. DISTRIBUTION OF FUNCTIONAL DISABILITY PRIOR TO FRACTURE OF THE HIP, ACCORDING TO AGE AND PRESENCE OR ABSENCE OF RHEUMATOID ARTHRITIS OR PREVIOUS CEREBRAL INFARCTION IN PATIENTS ADMITTED WITH SUCH FRACTURE TO A HOSPITAL FOR PROLONGED ILLNESS

AGE RANGE (YEARS)	DISABILITY IN ADL*	RHEUMATOID ARTHRITIS OR PREVIOUS CEREBRAL INFARCTION (NUMBER OF PERSONS)	
		PRESENT	ABSENT
50–69	Present	8	0
	Absent	1	9
70–89	Present	4	13
	Absent	2	45
90–99	Present	0	3
	Absent	0	5

*Disability in ADL (activities of daily living) was evaluated in relation to bathing, dressing, going to toilet, transferring, continence, and feeding. Disability was considered to be present in patients receiving supervision or personal assistance in one or more of the functions as defined in the Index of ADL (see text). Disability was considered to be absent if no supervision or personal assistance was received.

classified according to age, nursing time requirement, and cardiac status. In the second report, a new classification of functional status in activities of daily living was reported.[2] The classification, termed the "Index of Independence in Activities of Daily Living (Index of ADL)," had been evolved from an analysis of the first 106 evaluations of functional status in 45 consecutive patients. Included in the analysis were evaluations of status prior to fracture and 6 months and 1 year later. The Index of ADL included seven degrees of progressively increased dependence—classes A, B, C, D, E, F, and G. A class termed "Other" was included for exceptions, and only 1 evaluation of the 106 was in this class. It

should be noted that the index had been formulated on the basis of evaluations that had been made almost exclusively outside of a hospital setting. The advantages of the Index of ADL were many. It was more specifically ordered than scales that were previously available, permitting specific evaluating and ranking in order of patients. It thus served as a tool for comparing changes in patient status from one time to another and for comparing course of illness from one patient to another. Usefulness of the index in studying course of illness was demonstrated, as well as in teaching personnel involved in medical care.

The results in the present report extend the available data concerning the course of illness of fracture of the hip. The report deals with 6-month evaluations in 90 consecutive patients and 1-year evaluations in the first 82. The new Index of ADL, a graded scale of independence in walking, changes in residence status, and mortality have been used to describe course of illness. More exacting definitions of nursing time requirement and cardiac abnormality have been used than in the first report, while additional evaluations of course of illness have been made in groups of patients classified according to age and according to intelligence quotient.

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Boyd and George,[4] Soutter and Smith,[5] and Murray and Young[6] reported an increase in mortality with increasing age, but did not evaluate disability in relation to fracture of the hip. Cristophe and associates[8] and Murray and Frew[7] did study anatomic and functional disability in relation to fracture of the hip, e.g., in evaluations of treatment, but neglected an adequate study of the age factor. In the present study, age was found to be an important factor in evaluations of course of illness (Table I). The frequency of deterioration in activities of daily living and in walking increased with increasing age (Table I). Because of the relationship observed between age and course of illness, comparisons of course of illness in patients with anatomically different fractures were postponed pending the accumulation of sufficiently large numbers of patients to permit anatomic subclassification of each age group.

Evaluation of nursing time requirement in study patients revealed that patients who required relatively more nursing aid during the ninth and tenth weeks after fracture subsequently had an increased mortality rate. The same group of patients deteriorated more commonly in activities of daily living and in walking. The evaluation of the use of nursing time as a prognostic factor was part of a search for early means of predicting future needs of patients relative to assistance and supervision. The relationships noted between this measurement and subsequent disability encouraged the continuation of such studies.

In other studies of fracture of the hip, comparisons of relationships between cardiac abnormalities and course of illness were not reported, although concurrent illnesses, including cardiac complications, were generally thought to be associated with an unfavorable prognosis.[5,6] In the present study, deteriorations and mortality were more common in patients with evidence of congestive heart failure or recent or remote myocardial infarction than in patients without such evidence; however, the differences were not statistically significant (Table I). The magnitude of the frequency of deteriorations noted 1 year after fracture

among those with at least one of the cardiac abnormalities was nevertheless great, i.e., 67 per cent of patients deteriorated in activities of daily living, 40 per cent in walking, and 20 per cent in residence. Such great disability plus the fact that mortality in the cardiac group was 21 per cent at 1 year suggested that current methods of treatment had marked limitations in this group of patients and indicated the need for further study of the problem. It was considered, for example, that course of illness should be compared according to the presence or absence of cardiac abnormalities in each age group; however, the number of patients in the study was not yet large enough to permit such subclassification.

Differences in course of illness based on differences in intelligence classification were described in study patients (Table I). The use of intelligence quotients as a definitive measure of mental energy was a new attempt to relate course of illness to mental status, based on the assumption that mental acuity was an important requirement for good functional results and for a favorable prognosis in patients with fracture of the hip.[5,6] There was a trend toward more frequent deterioration in activities of daily living among patients with lower intelligence quotients. Of great interest were the high mortality and frequent deteriorations among the few patients who were either psychotic or aggressively hostile in refusing testing. The mortality rate at 1 year and the deterioration in walking were significantly greater in this group. Further study is indicated in relation to the problem of motivation, an important aspect of mental functioning that has eluded quantitative description and objective definition.

As previously stated, there was a relatively large proportion of deterioration in activities of daily living among the younger study patients, aged 50 to 69 years. In searching for possible causes, it was noted that the frequency of deterioration was greater among those who had been disabled prior to fracture than among those who had not; and such prior disability was more common in the youngest and oldest patients. It was noted, furthermore, that the presence of prior disability in the youngest group was closely related to the presence of rheumatoid arthritis or prior stroke. In considering these relationships, it should be noted that they do not necessarily apply to all patients with fracture of the hip, since they were based on observation of patients in a hospital for prolonged illness and not all patients with fracture of the hip go to such a hospital. Some, for example, crutch-walk early and are discharged directly home from the hospital of definitive treatment, while others die early. With these limitations in mind, the present study suggests that fracture of the hip may be an important risk in 50- to 69-year-old persons who have disabling rheumatoid arthritis or prior stroke. It may be that fractures of the hip, aside from those that are produced by accidents, are generally secondary to some other disability and that the primary disability varies from one age group to the next, including such conditions as rheumatoid arthritis or prior stroke in the 50 to 69 years age group and as yet less well-defined locomotor disabilities in older patients. In the United States, it has been estimated that 4 per cent of persons aged 45 to 64 years and 21 per cent of those aged 65 years or more have chronic mobility limitations.[9] It is conceivable that certain fractures of the hip and hence certain instances of chronic

mobility limitation can be prevented by mechanical or educational means directed toward patients having disabilities that are associated with the subsequent occurrence of fracture of the hip. In the continuing efforts of the current research program, additional clarification of the problems that have been discussed is being attempted. Further epidemiologic efforts are in progress to examine certain characteristics of patients with fracture of the hip who do not come to a hospital for prolonged illness in order to define the community role of such a hospital and in order to study the influence of patient selection on the relationships that have been described.

SUMMARY

In continuing studies at The Benjamin Rose Hospital, data were accumulated concerning the course of chronic illnesses. This report deals with patients who were admitted with fracture of the hip. Certain nursing, physical, and psychologic characteristics were prognostically related to mortality and to deterioration in activities of daily living, in walking, and in nature of residence. The significance of the relationships is discussed.

Deterioration in activities of daily living and in walking increased in frequency with increasing age, and a relatively large proportion of the youngest study patients showed deterioration in activities of daily living. Thirty per cent of surviving study patients 50 to 79 years old were at deteriorated levels in activities of daily living 1 year after the occurrence of the fracture, and 68 per cent of those 80 years or older were at deteriorated levels. Among surviving patients at 1 year after fracture, all but 1 (97 per cent) in the 60 to 79 years of age group were walking independently, while more than 40 per cent of those older than 79 were not. The mortality rate was 14 to 18 per cent at 1 year in patients aged 80 or more.

Patients who required relatively more nursing aid during the ninth and tenth weeks after fracture had a higher mortality rate and more frequent deteriorations in activities of daily living and in walking. Mortality was 27 per cent at 1 year in the more dependent group.

At both 6 months and 1 year after fracture, the proportions of deteriorations were greater in patients with congestive heart failure or with recent or remote myocardial infarction than in patients without any of these abnormalities; however, the differences were not statistically significant. At 1 year, the proportions of deterioration in the cardiac group were 67 per cent in activities of daily living, 40 per cent in walking, and 20 per cent in residence. The mortality rate reached a maximum of 21 per cent at 1 year in the cardiac group.

There was a trend toward more frequent deterioration in activities of daily living in patients with lower intelligence quotients as determined by the Wechsler Adult Intelligence Scale. Of interest were the high mortality rate and frequent deteriorations among the few patients in whom testing was incomplete because they were psychotic or aggressively hostile in refusing testing.

The frequency of deterioration in activities of daily living was greater in patients who had been disabled prior to fracture than in those who had not, and

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such prior disability was more common in the youngest and oldest patients. The presence of prior disability in the youngest group was, furthermore, closely related to the presence of rheumatoid arthritis or prior stroke. Continuing efforts are being made to define other primary disabilities associated with fracture of the hip as a preliminary step toward defining groups of aged persons with increased susceptibility to this fracture. In such groups, it might be possible to initiate mechanical or educational measures that would decrease the number of fractures and hence the number of instances of chronic mobility limitation in the United States.

We express sincere appreciation to Dr. George F. Badger, Dr. John H. Dingle, and Dr. Robert H. Ebert for guidance and assistance in their capacity as the advisory group to the research program.

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Book Review

PYELONEPHRITIS. By Fletcher H. T. Colby, M.D. Baltimore, 1959, Williams & Wilkins Company. Pp. 214, indexed. Price $7.50.

As indicated in the preface to his book, Dr. Colby has attempted to provide information on urinary tract infections that is of use to the general practitioner of medicine and to medical students. This monograph, therefore, is not a detailed review of pyelonephritis, but it does cover the subject adequately for its stated purpose. The author is obviously well informed about the many studies performed in recent years by nonurologists and his views, therefore, reflect a broad understanding of pyelonephritis. He suggests that collection of clear, voided urine specimens from women is undignified and catheterization is probably reasonably safe, although this opinion is at variance with the opinions of others. His suggestion on prophylactic chemotherapy to prevent infection following simple catheterization or instrumentation is also not widely accepted, although there are no data to refute his opinion. The tables giving information on the antibiotic sensitivities of bacteria responsible for urinary tract infection would be more meaningful if the number of strains studied as well as percentages were provided. On page 94 the author describes a patient with pyelonephritis associated with *Hemophilus influenzae* in the urine and suggests that this disease was attributable to an attack of influenza occurring 18 years previously. Such a relationship seems unlikely and, furthermore, there is no reason to suspect that the *H. influenzae* and the attack of influenza were associated with each other. Finally, the author suggests that bacterial counts in the urine of 1,000 colonies per milliliter may be indicative of urinary tract infection, whereas most workers in this area will accept only 10,000 colonies or more per milliliter as indicative of infection.

There are a few errors in the printing of the monograph, as illustrated on page 66 where "deprived" rather than "derived" is used, and on page 145, in the third sentence, where "in" is used rather than "is." On the whole this book can serve as a useful introduction to a consideration of pyelonephritis by physicians or students poorly informed about the subject. The book, however, will be of little or no value to the person relatively well aware of recent developments of knowledge about pyelonephritis.

Leighton E. Cluff, M.D.

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Announcements

A Postgraduate Seminar in Arthritis and Related Diseases will be held June 11 and 12, 1960, at the Diplomat Hotel, Hollywood-by-the-Sea, Florida (adjacent to Miami Beach), immediately following the Annual Meeting of the American Rheumatism Association and immediately preceding the Annual Meeting of the American Medical Association.

The sponsors of the Seminar are the Florida Chapter of the Arthritis and Rheumatism Foundation, the University of Miami Medical School, the University of Florida Medical College, and the South Florida Rheumatism Society (affiliated with the American Rheumatism Association).

The Faculty includes Leon Sokoloff, M.D., Gene H. Stollerman, M.D., Alexander B. Gutman, M.D., Edward F. Rosenberg, M.D., Charles Ragan, M.D., Joseph Lee Hollander, M.D., Philip S. Hench, M.D., Lawrence E. Shulman, M.D., Marian W. Ropes, M.D., Ephraim P. Engleman, M.D., David S. Howell, M.D., Theodore A. Potter, M.D., Morris Ziff, M.D., Theodore B. Bayles, M.D., and Edward W. Lowman, M.D.

Emphasis will be placed on diagnosis and management of the more common rheumatic disorders. This course is acceptable for eight hours of Category I credit by the American Academy of General Practice.

Tuition is $15.00, payable in advance. Checks should be made payable to the Treasurer, Florida Chapter, Arthritis and Rheumatism Foundation, 1206 Huntington Medical Bldg., Miami 32, Florida. For further information write to Seminar Committee, Florida Chapter, Arthritis and Rheumatism Foundation, 1206 Huntington Medical Bldg., Miami 32, Florida.

A 2-week Institute on Chronic Disease Control will be held June 13 to 24, 1960, at the University of Michigan School of Public Health. Cosponsors of the Institute with the School are the Directors of Chronic Disease Teaching Programs of Schools of Public Health, the Association of State and Territorial Chronic Disease Program Directors, the Michigan Department of Health, and the Public Health Service.

The program will include lectures, seminars, and discussions in the following areas: health promotion, prevention, early detection, multiple screening, home care, institutional care, and rehabilitation, in relation to such chronic diseases as heart disease, cancer, diabetes, glaucoma, and cerebral vascular disease.

The Institute is designed primarily for public health physicians concerned with chronic disease control programs, but selected public health nurse consultants, nutritionists, and health educators who are concerned with the planning and administration of chronic disease programs at state and local levels also will be eligible to attend.

Attendance will be limited, and application for participation in this Institute must be received not later than May 15, 1960. Additional information may be obtained by writing to the Director of Continued Education, School of Public Health, University of Michigan, Ann Arbor, Michigan.

A Short Course in Medical Genetics (Heredity and Disease in Man and Animals) will be conducted at Bar Harbor, Maine, Aug. 8 to 20, 1960, by members of the faculty of the Johns Hopkins University School of Medicine and the staff of the Roscoe B. Jackson Memorial Laboratory. Forty participants can be accommodated. The course is designed primarily for persons in medical teaching and research. Further information can be obtained from the codirectors of the course: Dr. Victor A. McKusick, Johns Hopkins Hospital, Baltimore 5, Maryland, and Dr. John L. Fuller, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

THE 1960-1961 SESSION OF THE TRAINING PROGRAM FOR STEROID BIOCHEMISTRY is announced by the Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts, with the Department of Chemistry, Clark University, Worcester, Massachusetts, and the Department of Biochemistry, College of Medicine, University of Utah, Salt Lake City, Utah.

To alleviate the shortage of qualified trained personnel in steroid research, a training program will be sponsored by the United States Public Health Service through the National Cancer Institute of the National Institutes of Health. The courses will stress both theoretic and practical aspects, as well as specialized laboratory techniques in steroid research.

Postdoctoral candidates (M.D. or Ph.D.) selected for admission both at Worcester and Utah will receive stipends of $5,500 for a 1-year period. Predoctoral candidates (B.S., M.S., or equivalent) selected for admission (only at Worcester) will receive stipends of $1,800 for a 6-month period.

All inquiries and requests for applications should be directed to: Dr. Kristen Eik-Nes, Department of Biochemistry, College of Medicine, University of Utah, Salt Lake City, Utah, or Dr. William R. Nes, Department of Chemistry, Clark University, 950 Main St., Worcester, Massachusetts.

Classes start Oct. 1, 1960. The final date for completion of application is June 1, 1960

THE AMERICAN COLLEGE OF SURGEONS' 46TH ANNUAL CLINICAL CONGRESS will be held Oct. 10 to 14, 1960, in San Francisco, California. For information write to Dr. William E. Adams, Secretary, American College of Surgeons, 40 East Erie St., Chicago 11, Illinois.

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